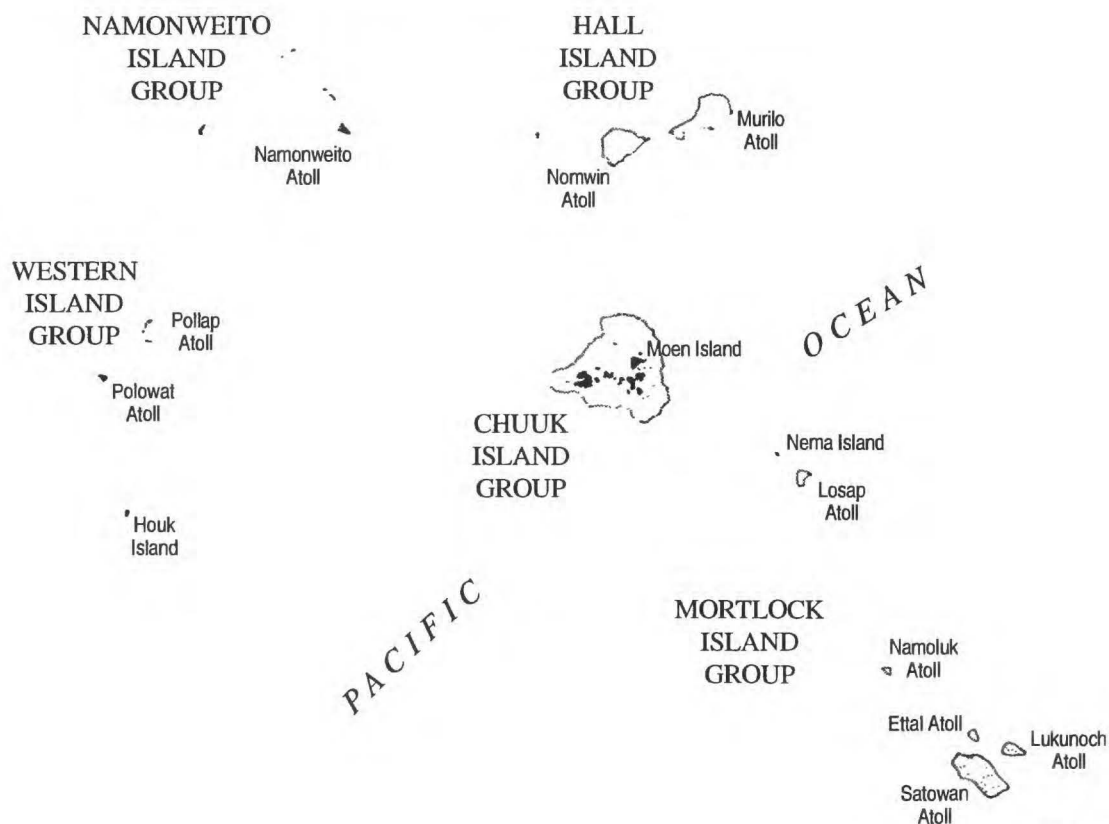


# WATER-QUALITY RECONNAISSANCE OF GROUND WATER IN THE INHABITED OUTER ISLANDS OF CHUUK STATE, FEDERATED STATES OF MICRONESIA, 1984–85

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U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 96-4180



Prepared in cooperation with the  
GOVERNMENT OF CHUUK STATE,  
FEDERATED STATES OF MICRONESIA



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*By* Scott N. Hamlin and Kiyoshi J. Takasaki

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Honolulu, Hawaii  
1996

U.S. DEPARTMENT OF THE INTERIOR  
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U.S. GEOLOGICAL SURVEY  
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## Conversion Factors

Multiply	By	To obtain
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
gallon per day (gal/d)	0.00004381	cubic decimeter per second
inch (in.)	25.4	millimeter
inch (in.)	2.54	centimeter
inch per year (in/yr)	2.54	centimeter per year
mile (mi)	1.609	kilometer
square foot (ft <sup>2</sup> )	0.09294	square meter

**Temperature** is given in degrees Fahrenheit (°F), which can be converted to degrees Celsius (°C) by the following equation:

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) / 1.8$$

**Specific conductance** is given in microsiemens per centimeter (μS/cm) at 25° Celsius. Microsiemens per centimeter is numerically equal to micromhos per centimeter.

**Abbreviations used:** mg/L, milligram per liter; μg/L, microgram per liter

# Water-Quality Reconnaissance of Ground-Water in the Inhabited Outer Islands of Chuuk State, Federated States of Micronesia, 1984–85

By Scott N. Hamlin and Kiyoshi J. Takasaki

## Abstract

A reconnaissance of ground-water quality in 24 inhabited outer islands in Chuuk State was made between January 1984 and October 1985. Most of the islands are part of low-lying coral atolls within the Western, Namonuito, Hall, and Mortlock Island Groups. A total of 648 wells were located and sampled for temperature and specific conductance. A few miscellaneous sites such as taro patches also were sampled. The nitrate concentration was determined for 308 water samples. To develop a relation between specific conductance and chloride concentration, the chloride concentration was determined for 63 water samples. In addition, 21 water samples were analyzed for major and trace constituent ion concentrations.

Chloride and nitrate are the primary constituents affecting the potability of ground water in the inhabited outer islands of Chuuk State. The source of chloride in ground water is seawater, whereas nitrate is derived from plant and animal waste materials. The chloride concentrations in many well waters exceed the World Health Organization guideline for drinking water, particularly in wells near the shoreline or on small islands. In addition, the nitrate concentrations in some well waters exceeded the World Health Organization guideline for drinking water.

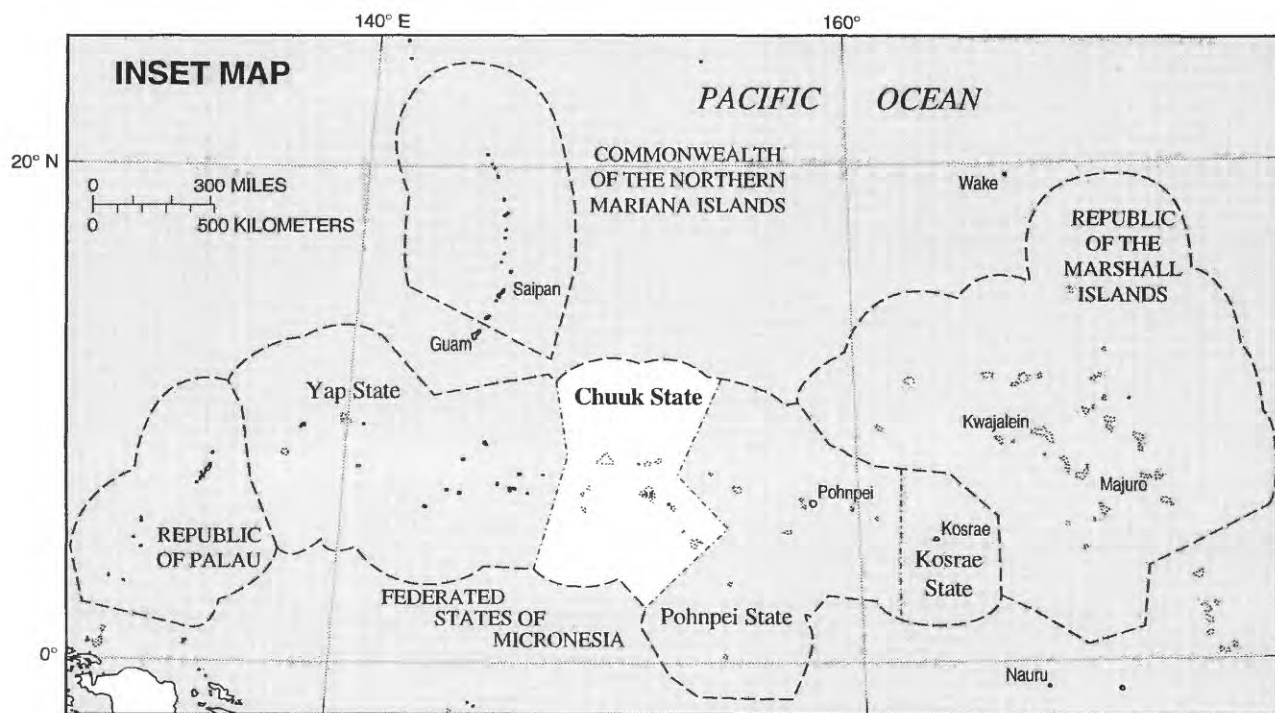
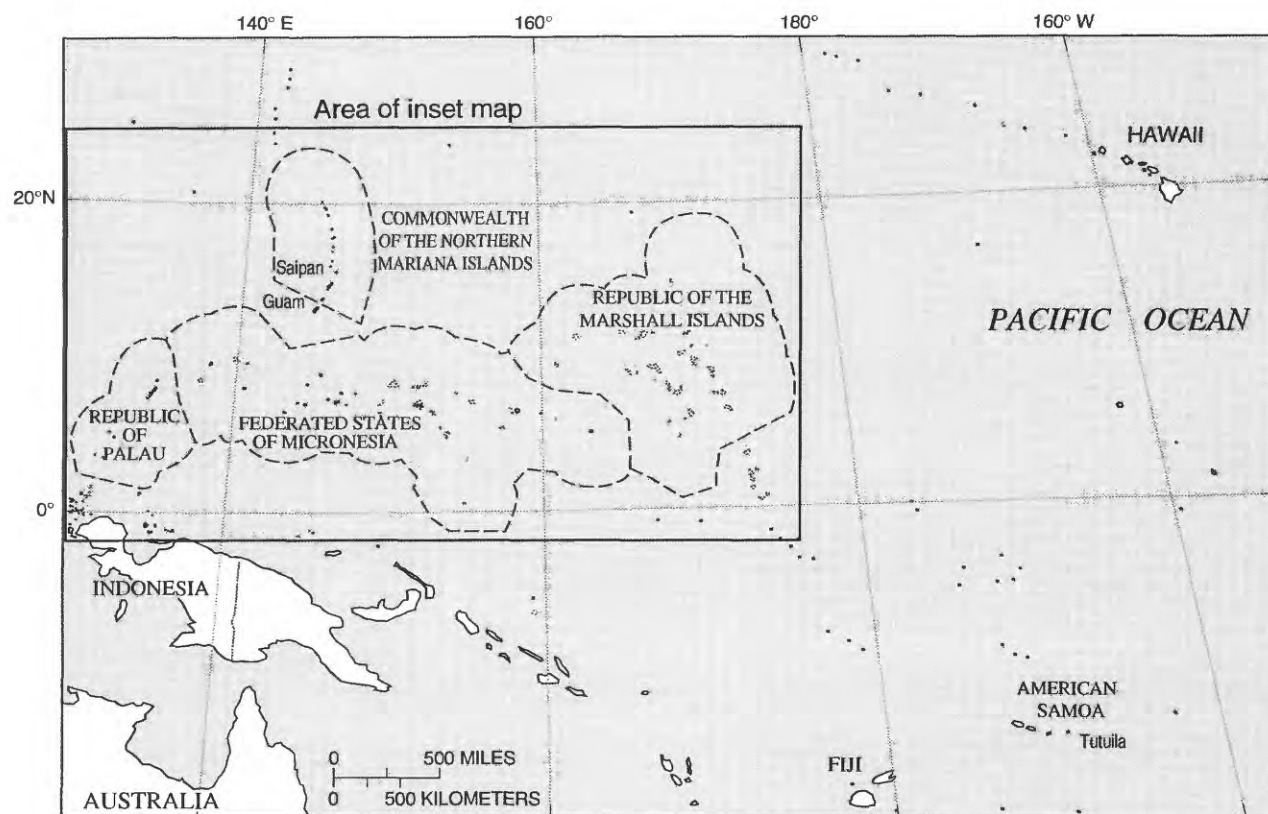
## INTRODUCTION

The demand for water on the inhabited outer islands of Chuuk State (formerly known as Truk) in the Federated States of Micronesia (fig. 1) is expected to increase as a result of a desire to construct additional sanitary facilities such as showers, flush toilets, and laundry facilities. Water supplies on these islands are obtained from individual and community rainwater-catchment systems and from shallow dug wells that yield fresh to brackish ground water. During extended dry periods the demand for potable water commonly exceeds the supply.

Water-supply shortages on the outer islands of Chuuk State were accentuated during a drought in 1983. Rainfall on the island of Moen in the Chuuk Island Group was only 31 percent of normal for the period October 1982 through May 1983 (van der Brug, 1986). The subnormal rainfall created a severe shortage on the outer islands because most of the potable water on these islands comes from rainwater-catchment systems. In addition to strict rationing of the water supply, it was necessary to use shallow dug wells as a source of drinking water. In some cases, drinking water was shipped to the islands most seriously affected by the drought. One way to alleviate the chronic water-supply shortage would be to further develop ground-water resources for non-potable use so that rainwater can be saved for drinking and cooking.

To help address the water-supply concerns of the inhabited outer islands of Chuuk State, the U.S. Geolog-





**Figure 1.** Chuuk State, Federated States of Micronesia.

ical Survey, in cooperation with Chuuk State, made a ground-water-quality reconnaissance of 24 islands between January 1984 and October 1985. This report documents the results of the reconnaissance survey. The geohydrologic framework of atoll islands is presented as background information.

## Setting

The islands of Chuuk State are located between latitude 4° to 10°N and longitude 148° to 154°E in the western Pacific Ocean, and can be divided into five major island groups (fig. 2). The largest is the Chuuk Island Group, which is a complex of mountainous islands of volcanic origin surrounded by low-lying coral islands. Major outer island groups are the Western, Namonuito, Hall, and Mortlock island groups. The outer island groups of Chuuk State mostly are composed of low-lying coral atoll islands, and are the area of study discussed in this report.

The climate of Chuuk State was described by Stark and others (1958). Mean annual temperature is about 81°F (27°C) and is uniform throughout the year. Relative humidity ranges from about 55 to 100 percent and generally is more than 75 percent. Rainfall is heavy, averaging about 140 in/yr; however, droughts are common. Chuuk State lies in an elongated area of high rainfall centered about 100 mi south of Pohnpei at about latitude 5°N and longitude 159°E (fig. 3). The area of high rainfall, with more than 140 in/yr, extends eastward beyond Majuro and westward to Palau for a distance of more than 2,000 mi. North and south the area of high rainfall extends for a total of about 300 mi. The mean annual rainfall for the Chuuk Island Group ranges from about 100 to 180 in. Data from the National Weather Service rain gage at Moen Airport, for the 33-year period 1952–85, indicate that the area receives an average of about 140 in/yr of rainfall. Most of the year is wet, except for the period from January through March when the monthly rainfall is only about half that of the other 9 months.

The amount and distribution of rainfall in the outer islands of Chuuk State probably are not significantly different from that of Moen. The regional rainfall map (fig. 3) shows that the rainfall in the outer islands is higher to the south and east and lower to the north and west of the Chuuk Island Group. However, considerable short-term variability in rainfall can be seen in a com-

parison of monthly rainfall data for Moen in the Chuuk Island Group, Polowat Atoll in the Western Island Group, and Lukunoch Atoll in the Mortlock Island Group for the period January 1987 through December 1988 (fig. 4). Polowat and Lukunoch Atolls are about 185 miles west and south of Moen, respectively.

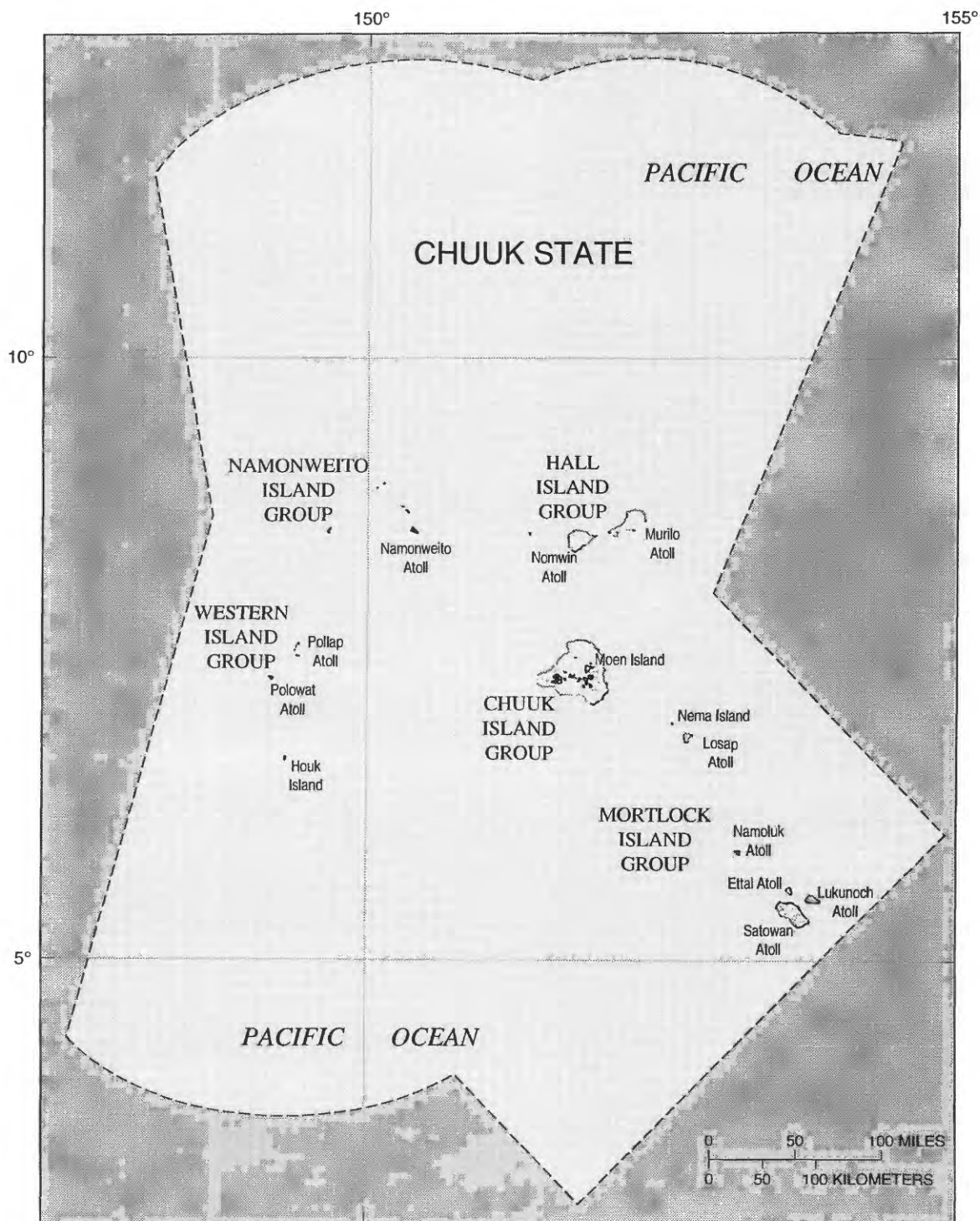
Although typhoons are not common, several have passed near or over the islands of Chuuk State. Typhoons have caused loss of life, widespread damage to buildings and crops, and wave damage to shoreline and coastal structures.

## Methods of Data Collection

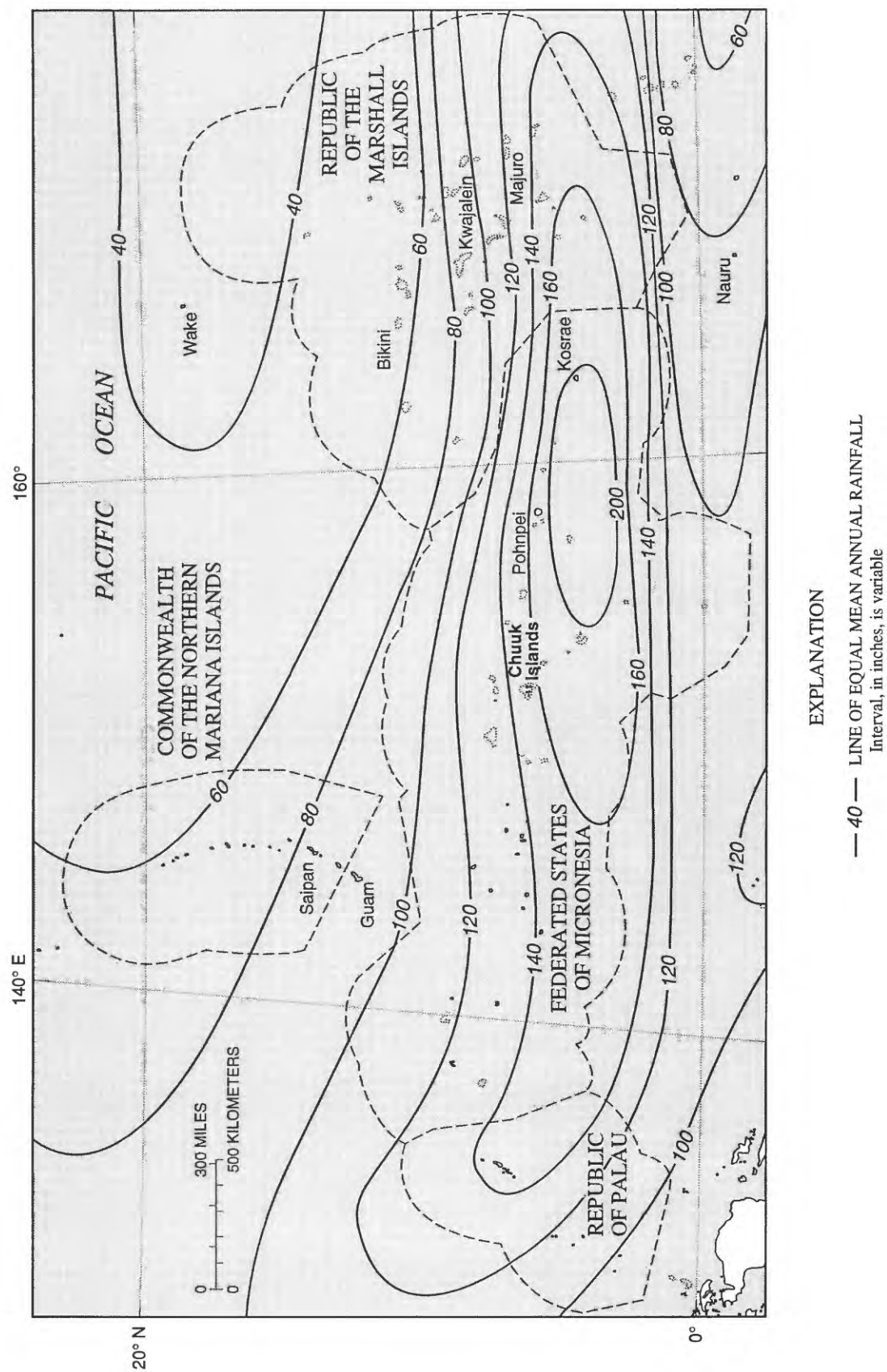
The reconnaissance survey of the inhabited outer islands of Chuuk State began in January 1984 and was completed in October 1985. The reconnaissance was limited to the stay of the interisland (field) ship that visits each island once every 4 to 6 weeks. This and another similar ship provide the principal means of transporting people and cargo between the administrative center on Moen in the Chuuk Island Group and the outer islands in the Western, Namonuito, Hall, and Mortlock Island Groups. The duration of stay at each island was normally 1 day. Occasionally, the visits ranged from as short as one-half day to as long as several days.

An inventory of all known dug wells on each of the inhabited islands was made. The water from each well was sampled for measurement of temperature and specific conductance. Selected wells were sampled for measurement of pH, and for analysis of chloride and nitrate concentrations. At least one well in each island group was sampled for analysis of major and trace constituent ion concentrations. A spot sampling was made of ground water in taro patches, especially where the water was reported to be brackish. On at least one island in each island group, a well point was driven and a hand pump installed for demonstration purposes.

Dip samples were collected from dug wells and taro patches. The driven wells installed during the survey were sampled with a hand pump after the specific conductance of the pumped water stabilized and clarity was attained indicating sufficient well development. Temperature, pH, specific conductance, and nitrite concentration were determined in the field. Samples for major and trace constituent ion analysis were preserved for analysis at the U.S. Geological Survey's Central Laboratory (Denver, Colorado).

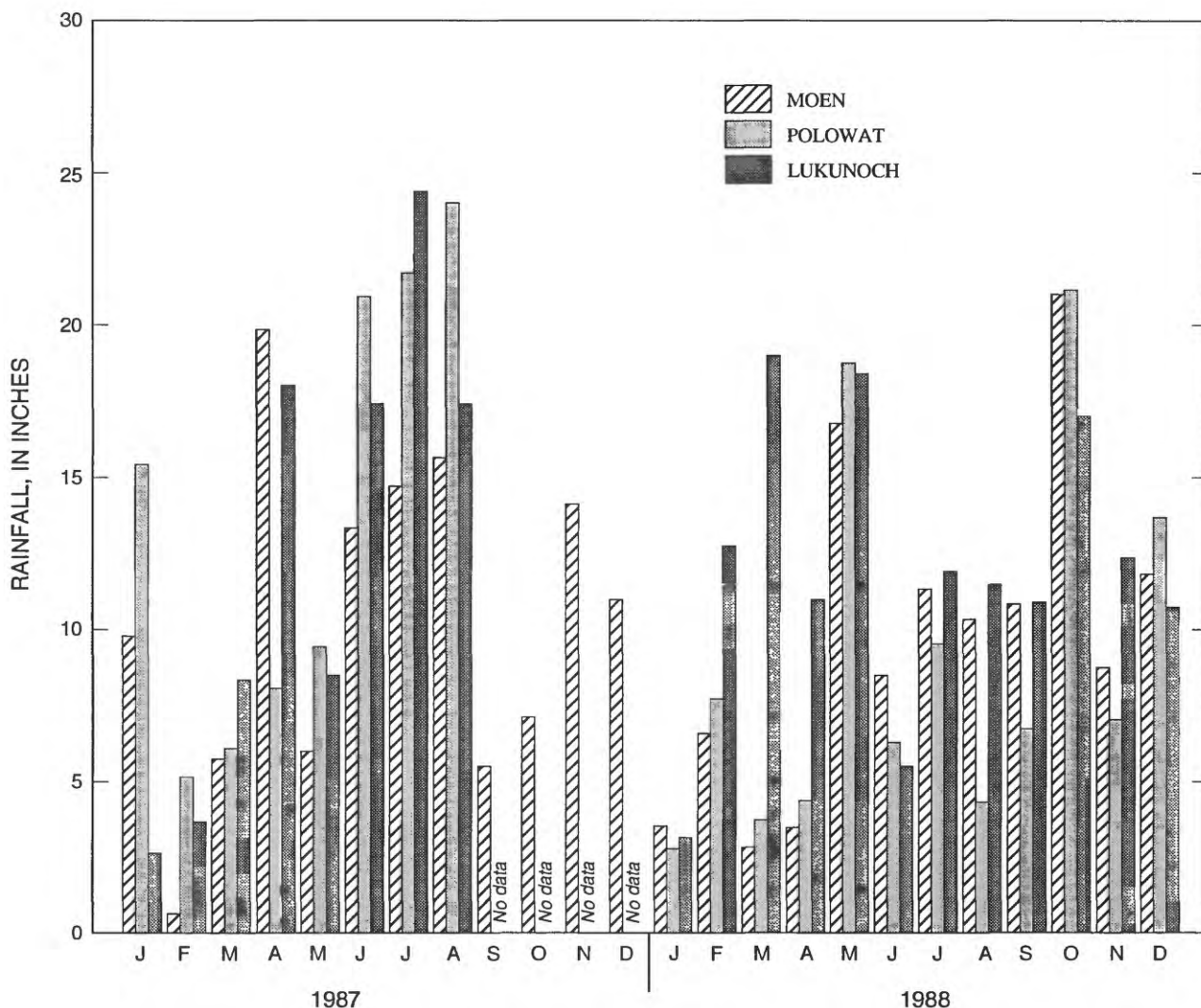


**Figure 2.** Island groups in Chuuk State, Federated States of Micronesia.



**Figure 3.** Mean annual rainfall in the western Pacific (modified from Taylor, 1973).





**Figure 4.** Monthly rainfall for Moen, Polowat, and Lukunoch Islands, Chuuk State, 1987–88 (data from National Oceanic and Atmospheric Administration, 1987, 1988).

## Acknowledgments

The Department of Public Works on the island of Moen in the Chuuk Island Group provided assistance in: (1) scheduling transportation to and from the outer islands, (2) installing well points, and (3) collecting hydrologic data. The Department of Transportation provided itineraries for trips to and from the outer islands and helped coordinate field surveys. Special appreciation is given to the Chief Magistrates of the outer islands, and to the individual well owners, for their

assistance in locating wells and facilitating the collection of hydrologic data.

## GEOHYDROLOGY

Most of the outer islands in the Chuuk State are part of low-lying coral atolls. Atolls are sub-circular reefs composed of a resistant framework of calcareous skeletons enclosing a lagoon from the open sea. The upper surface of the reef structure is flat and is constantly scoured and planed off by wave action and dissected

by seaward-trending surge channels. The reef structure is derived from fringing reefs that surround a volcanic island. As the volcanic island sinks under its own weight, reef organisms build upward in an attempt to keep pace with the relative rise in sea level. The volcanic island eventually is submerged, leaving only the reef and related unconsolidated sediments that form atoll islands.

As part of the environmental studies made in the Marshall Islands in connection with atomic-bomb testing, the U.S. Navy drilled a series of deep test holes on Enewetak Atoll. Two of the test holes went through a 3,900-ft cap of shallow-water reef limestone and bottomed in volcanic material (basalt). The structure and composition of the shallow-water reef limestones forming the atoll were found to be affected by several changes in sea level (Schlanger, 1963). During the Pleistocene epoch, four or more cycles of sea-level rise and fall occurred. Sea level rises during interglacial periods, and falls during glacial periods. With each drop in sea level, as much as 300 vertical ft of reef and lagoonal sediments were exposed to subaerial weathering and erosion. The subsequent rise in sea level caused an accumulation of new reef and lagoonal sediments over the preceding erosional unconformity. These fluctuations affected carbonate depositional sequences on oceanic islands worldwide.

## Geohydrologic Units

The processes that form atolls also produce variations in lithology that affect the occurrence and flow of fresh ground water. In general, fine-grained unconsolidated sediments are deposited on the lagoonside of atoll islands and coarser materials are deposited on the oceanside. The fine-grained and well-sorted lagoonal deposits retard the movement of ground water and restrict mixing with saltwater. In contrast, the coarse and poorly sorted materials on the oceanside of an atoll island facilitate both the flow of ground water and the mixing of fresh ground water with saltwater.

The general geohydrologic characteristics of atoll islands has been described by Ayers and Vacher (1986). The geohydrologic framework of an atoll island can be considered to consist of three units (fig. 5A). The first unit is the reef flat which forms a stable foundation upon which the island's surficial sediments accumulate. This unit thins from the reef front lagoonward pinching

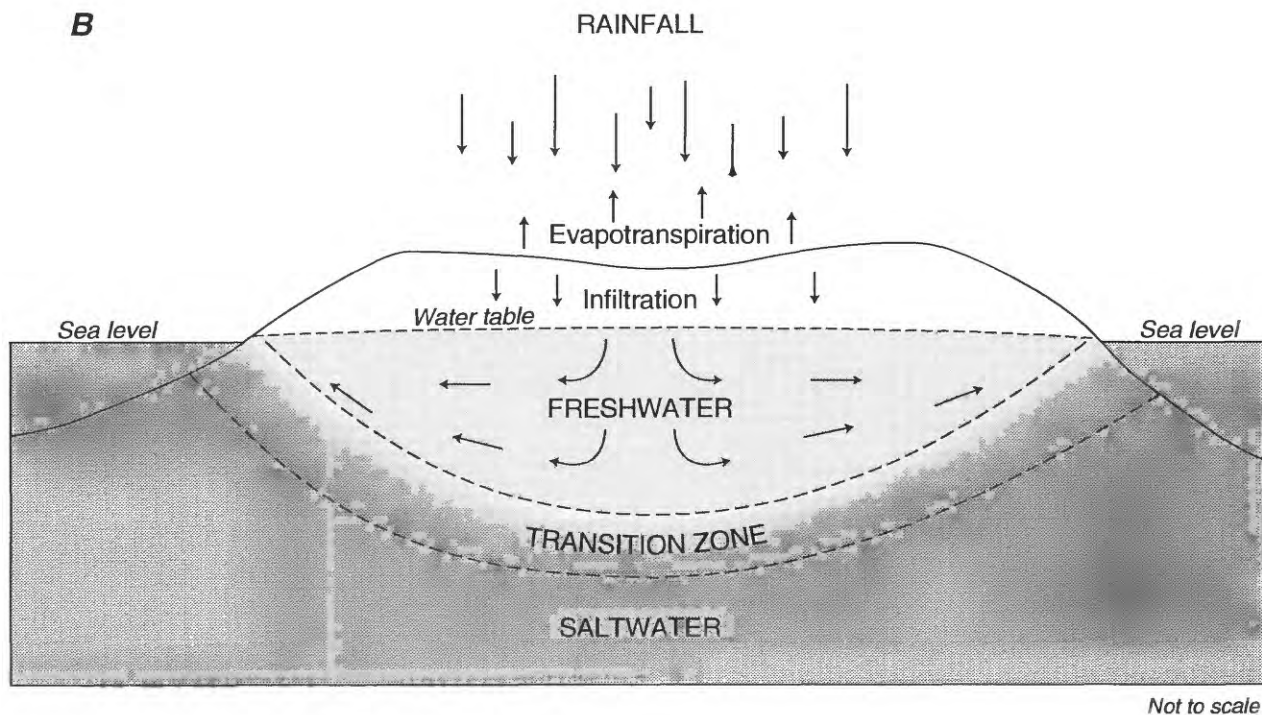
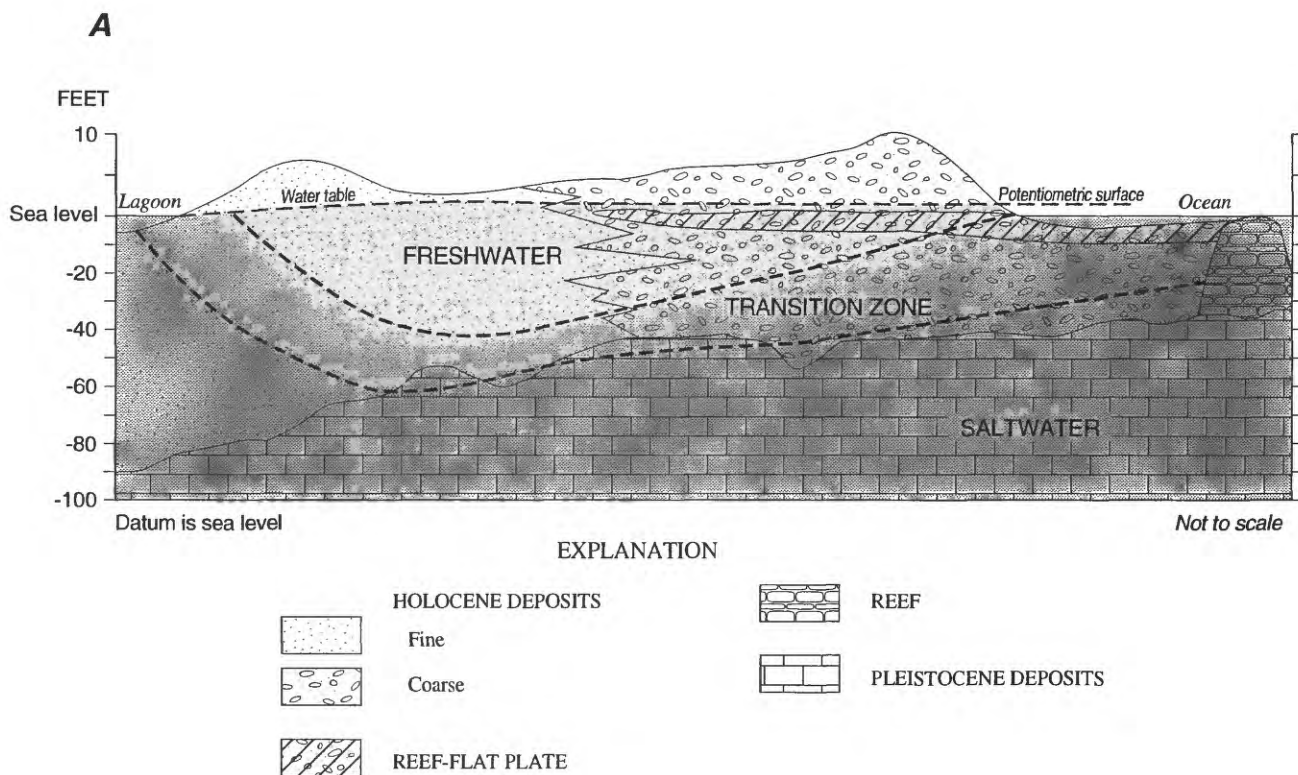
out at some distance beneath the island. The permeability of the reef flat is less than that of the underlying unconsolidated sediments. Where the reef flat extends beneath the island, it acts as a confining layer impeding recharge.

The second unit consists of unconsolidated deposits of Holocene age. These deposits occur beneath the soil zone and are composed of silt- to gravel-sized fragments of foraminifera, *Halimeda*, and coral. Layering and lateral gradation of these deposits affect the occurrence and flow of fresh ground water. Analysis of ground-water tidal fluctuations and grain-size distributions indicate a general areal variation in permeability across an atoll island: relatively high values for sediments bordering the ocean, and lower values for sediments adjacent to the lagoon (Anthony and others, 1989). The presence of lower permeability sediments adjacent to the lagoon results in a lens of fresh ground water that is thicker on the lagoonside of an atoll island.

The third unit consists of highly permeable deposits of Pleistocene age that underlie the Holocene deposits. The primary skeletal material of the Pleistocene deposits is similar to that of the Holocene deposits. The contact between the Holocene and Pleistocene deposits is typically at depths of 50 to 80 ft below sea level and represents a pronounced permeability contrast in which the Pleistocene deposits are more permeable than the Holocene deposits. The highly permeable Pleistocene deposits at Majuro Atoll in the Marshall Islands were found to contain seawater and thin the zone of transition between freshwater and seawater beneath that part of the freshwater lens that is sufficiently thick to extend down to the Pleistocene deposits (Anthony and others, 1989). Core drilling was not done on the outer islands of Chuuk State; however, the islands probably have undergone about the same depositional and tectonic histories and sea-level changes as other atolls in the western Pacific. Therefore, similar geohydrologic conditions probably exist in the outer islands of Chuuk State.

## Occurrence and Development of Ground Water

The highly permeable soils that form most atoll islands are readily infiltrated by recharge from rainfall. The island intercepts rainfall; a fraction of the rainfall is lost to evapotranspiration, and the remainder infiltrates



**Figure 5.** Schematic sections of an atoll island showing **A**, conceptual hydrogeologic framework (modified from Ayers and Vacher, 1986), and **B**, freshwater lens with transition zone (modified from Hamlin and Anthony, 1987).



the island's sediments. Because of the high permeability of the soils, there is no surface runoff. If the infiltration from rainfall is sufficiently great, a lens-shaped fresh ground-water body forms. The less-dense freshwater floats on the more-dense seawater, somewhat like an iceberg floating in the ocean (fig. 5B). Fresh ground water moves radially outward from the island's center toward the shoreline and discharges to the sea. Some of the freshwater mixes with the underlying seawater to form a zone of transition between freshwater and seawater. As a result of the difference in density between freshwater and seawater, the lens of freshwater extends to a depth of about 40 times the elevation of the lens surface above sea level. This 40:1 ratio is known as the Ghyben-Herzberg relation. The actual thickness of freshwater is influenced by the recharge and discharge rates, the size and shape of the island, and the hydraulic characteristics of the geohydrologic units.

The distribution of fresh ground water in atoll islands primarily is controlled by the size and shape of the island and by variations in the hydraulic characteristics of the geohydrologic units. Large, circular islands generally have large freshwater lenses. Small, elongated islands promote mixing of freshwater with seawater, and are associated with thin freshwater lenses and thick transition zones. The thickest part of the freshwater lens often is found in the fine-grained sediments on the lagoonside of the islands.

Although rainwater is the preferred source for water supply on atoll islands, ground water from shallow dug wells often is used during periods of drought. Historically, ground water was developed for taro cultivation. Taro commonly is cultivated in an elongated interior or central depression between the ocean and lagoonside beach ridges. For the cultivation of wetland taro, the islanders have deepened the central depressions to expose the water table.

During World War II, the Japanese population on the outer islands of Chuuk had a significant effect on the development of water, both in method and quantity (Father Hezel, oral commun., 1984). Between 1934 and 1945 the Japanese population increased from about 25 to about 5,000, almost doubling the population on the outer islands. The Japanese constructed cisterns to collect rainwater; many of the cisterns were still functional in 1984. With the knowledge that ground water provides a water supply that is less affected by short-term variations in rainfall than rainwater-catchment systems,

the Japanese developed ground water for washing dishes and clothes, and to take baths. Many of the dug wells inventoried as part of the reconnaissance survey were constructed by the Japanese during World War II. Most of these wells are lined and curbed with concrete. During droughts and extended dry periods, ground water was and remains the sole source of water supply.

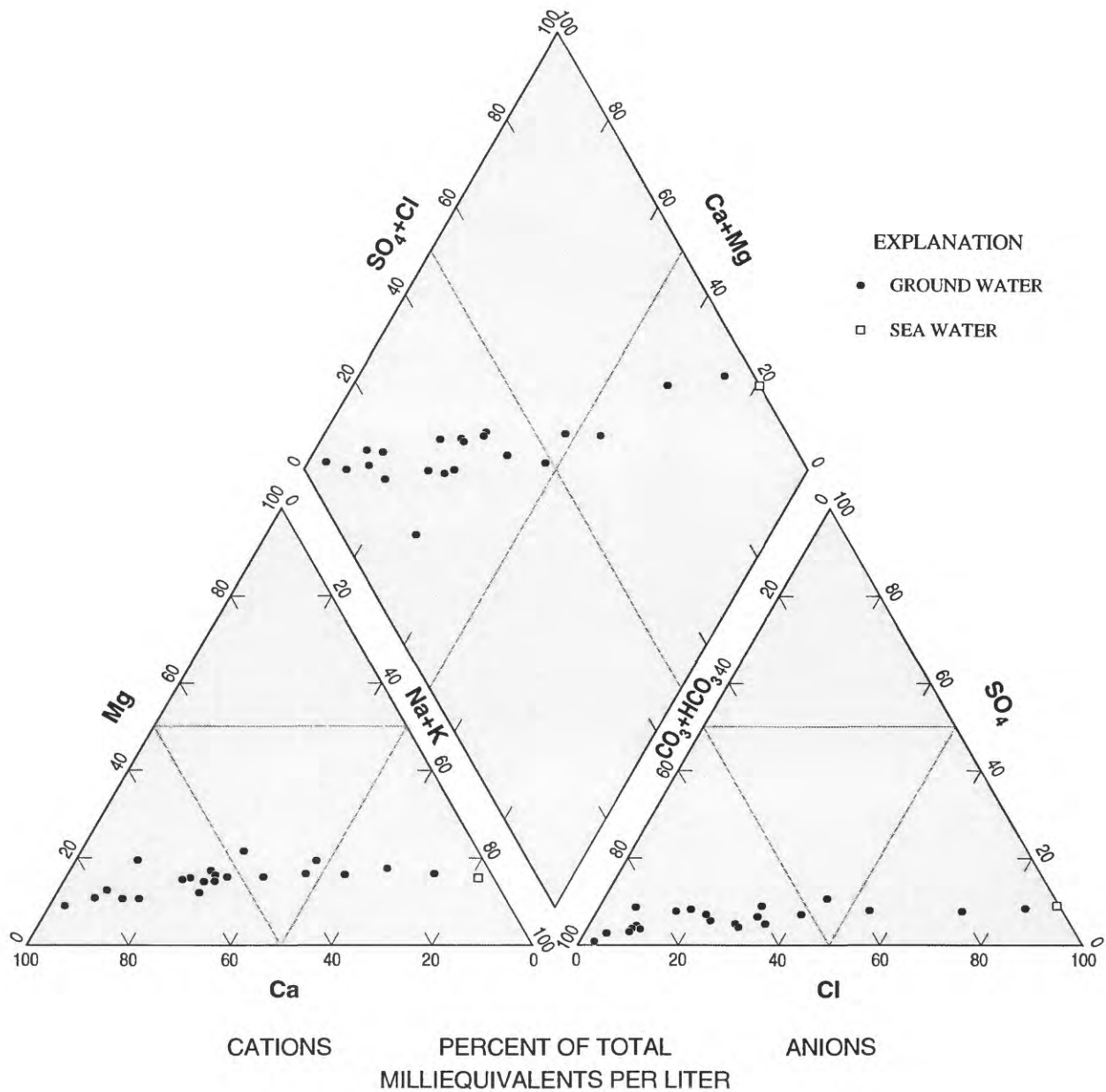
All wells on atoll islands are susceptible to contamination from the surface because of the shallow depth to water (less than 10 ft) and high permeability of soils. Wells could be constructed to minimize contamination from the surface with a cover or raised concrete platform (minimum lateral extension of 1 ft and minimum height of 1 ft), and cemented or solid casing (at least 1 ft below the water table). This type of well (fig. 6) could be equipped with a hand or solar pump.

To minimize potential contamination, the wells could be located inland and upgradient of toilets, pig pens, and other sources of pollution. Water in the freshwater lens flows radially outward from a central high area to the surrounding ocean. This high area in the water surface usually is located on the lagoonside of the island, corresponding to the thickest part of the lens and greatest accumulation of fine-grained sediments (Hamlin and Anthony, 1987). If sources of contamination were restricted from this area, wells located here would tap the cleanest and thickest part of the freshwater lens.

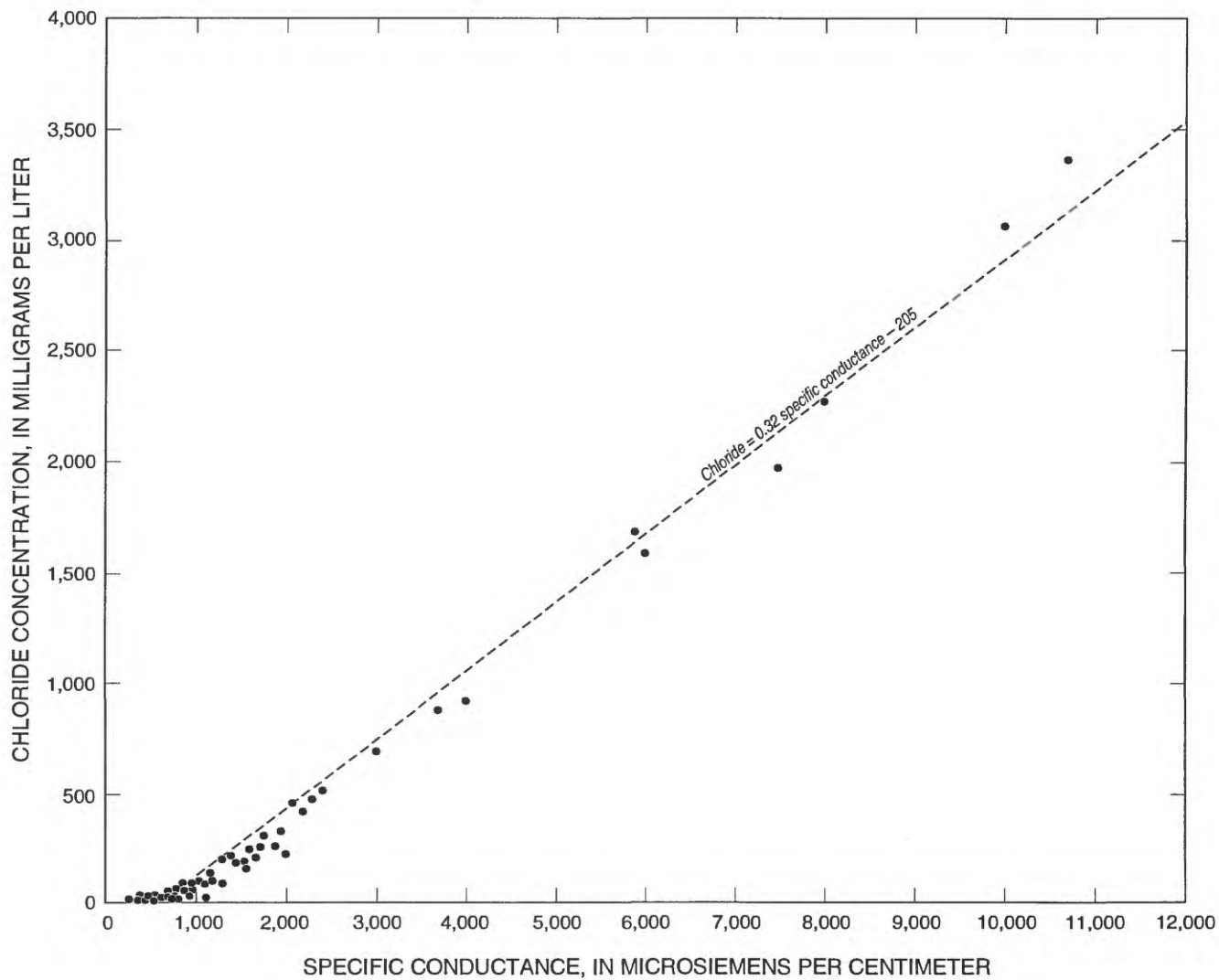
## **WATER QUALITY IN THE INHABITED OUTER ISLANDS**

Major ion data for selected dug wells are shown graphically in a trilinear diagram (fig. 7). Trilinear diagrams display the relative proportions of the most common cations and anions, thereby allowing a comparison of the waters with different total chemical concentrations (Hem, 1985). This type of diagram conveniently shows the effects of mixing water from different sources. Data from samples of ground water from the outer islands of Chuuk State form a straight line on this diagram (fig. 7). This relation indicates simple mixing of fresh ground water with seawater. The end points of this line are sodium-chloride (seawater) and calcium-carbonate (fresh ground water) compositions. Dissolution of carbonate minerals by rainwater produces a calcium-carbonate ground water. Mixing of calcium-carbonate





**Figure 7.** Trilinear diagram showing the range in composition of ground water from dug wells in the inhabited outer islands, Chuuk State, 1984–85.



**Figure 8.** Relation between specific conductance and chloride concentration in ground water from the inhabited outer islands, Chuuk State, 1984-85.

Values of specific conductance less than 1,500  $\mu\text{S}/\text{cm}$  generally are within the guideline for chloride concentration (250 mg/L) recommended for drinking water by WHO. Water from many of the wells on outer islands in Chuuk State exceed the WHO (1984) guideline for chloride in drinking water. Seawater is the main source of chloride in ground water. Chloride is introduced to ground water from sea spray, wave washover, and seawater intrusion.

One of the most common contaminants in ground water is dissolved nitrogen (N) in the form of nitrate. Excessive nitrate concentrations in drinking water may cause methemoglobinemia in infants. The WHO (1984) guideline for nitrate in drinking water is 10 mg/L (as N). High levels of nitrate in ground water may indicate contamination from fertilizers or human waste. The presence of nitrate may be associated with pathogenic bacteria from human or animal waste. Natural sources of nitrate in water include atmospheric nitrogen fixation by some plants, plant decay, and animal waste. Nitrate (as N) data reported in this report may be converted to nitrate (as  $\text{NO}_3$ ) using a multiplication factor of 4.4. For example, the safe drinking-water limit of 10 mg/L (as N) is equivalent to a nitrate concentration of 44 mg/L (as  $\text{NO}_3$ ).

Trace-element analyses of ground-water samples from selected wells for each island group are listed in tables 1, 6, 12, and 17. All of the measured concentrations of trace elements were within the WHO (1984) guideline for drinking water. Elevated concentrations of trace elements in some of the water samples are most likely related to the casing and to other foreign materials placed in the well. Many of the dug wells were cased with 55-gal oil drums made of metal. Some of the metals that were detected in well water may have been derived from corrosion or leaching of the 55-gal oil drum casing.



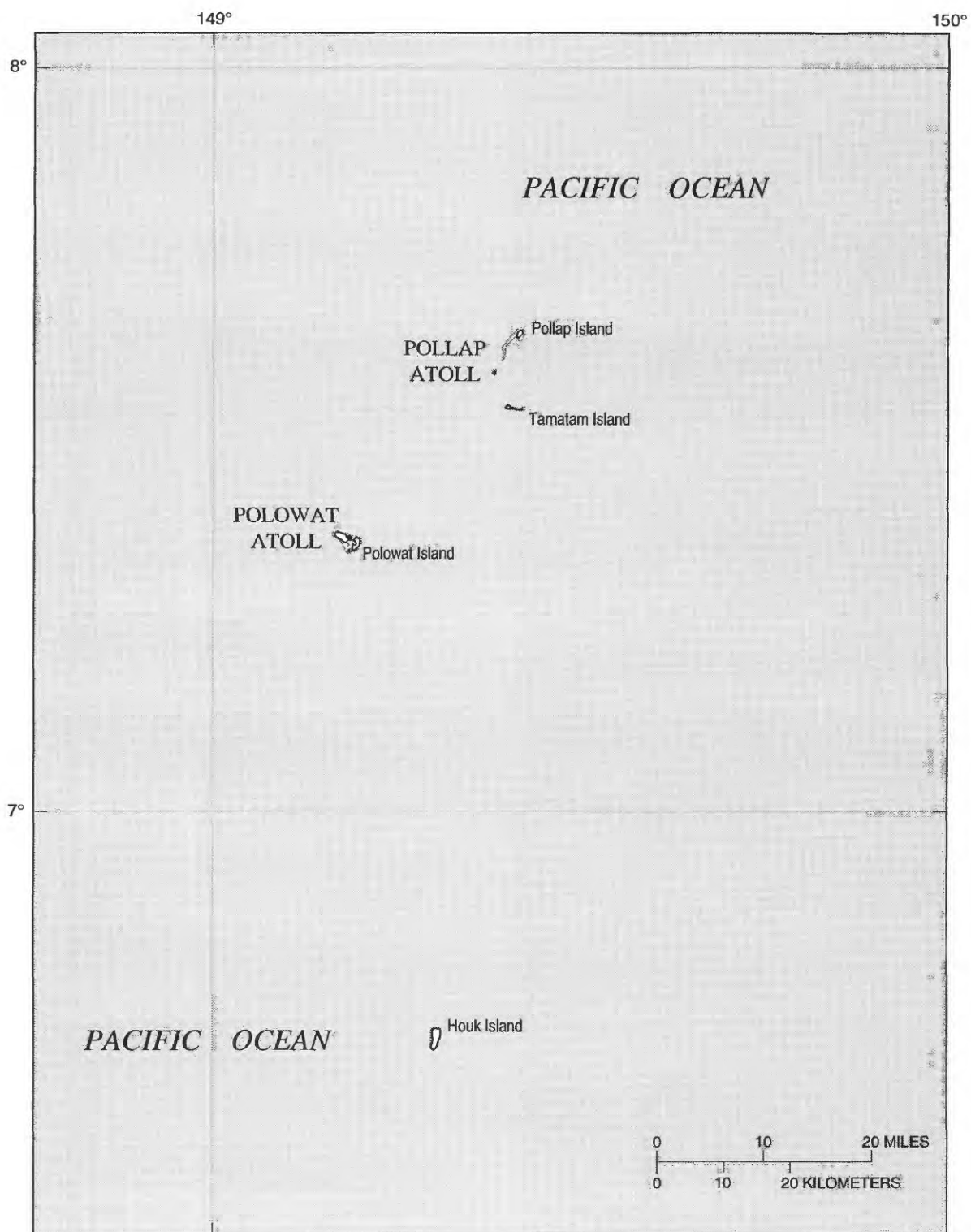
## Western Island Group

The inhabited islands of the Western Island Group are Pollap and Tamatam at Pollap Atoll, Polowat at Polowat Atoll, and Houk (fig. 9). These islands are about 185 mi west of the Chuuk Island Group. Mean values for specific conductance of ground water on each of the islands ranged from 700  $\mu\text{S}/\text{cm}$  on Houk to 1,510

$\mu\text{S}/\text{cm}$  on Tamatam. Field determinations for nitrate concentration of ground water ranged from less than 1 mg/L (as N) at selected sites on each of the islands, to a high of 10 mg/L (as N) on Houk Island. Table 1 includes physical, major-ion and trace-element data for selected wells in the Western Island Group. Specific information for each of the islands is presented below.

**Table 1.** Physical, major ion, and trace element data for selected wells in the Western Island Group, Chuuk State  
[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25°C; mg/L, milligrams per liter;  $\mu\text{g}/\text{L}$ , micrograms per liter;  $\text{CaCO}_3$ , calcium-carbonate; --, not measured; <, less than]

Property or constituent	Units	Pollap well 11 02/04/84	Tamatam well 2 02/03/84	Polowat well 32 01/31/84	Houk well 7 02/05/84
Specific conductance	$\mu\text{S}/\text{cm}$	1,150	1,600	517	1,100
pH	units	6.7	7.2	6.4	6.9
Temperature	°C	27.0	27.0	27.5	27.5
Hardness as $\text{CaCO}_3$	mg/L	420	430	300	420
Calcium, total as Ca	mg/L	130	110	110	130
Magnesium, total as Mg	mg/L	23	38	6	23.5
Sodium, total as Na	mg/L	87	170	4	34.2
Potassium, total as K	mg/L	1.5	13	<0	75.1
Alkalinity, total as $\text{CaCO}_3$	mg/L	383	371	313	491
Sulfate, dissolved as $\text{SO}_4$	mg/L	28	87	3	20.5
Chloride, dissolved as Cl	mg/L	150	250	5	39.3
Fluoride, total as F	mg/L	0.2	0.2	0.2	0.3
Silica, dissolved as $\text{SiO}_2$	mg/L	0.4	1.6	0.25	2.5
Dissolved solids, calculated, sum of constituents	mg/L	652	--	--	677
Aluminum, total as Al	mg/L	10	30	10	20
Arsenic, total as As	$\mu\text{g}/\text{L}$	<1	<1	<1	<1
Barium, total as Ba	$\mu\text{g}/\text{L}$	<100	<100	<100	<100
Beryllium, total as Be	$\mu\text{g}/\text{L}$	<10	<10	<10	<10
Cadmium, total as Cd	$\mu\text{g}/\text{L}$	<1	3	<1	<1
Chromium, total as Cr	$\mu\text{g}/\text{L}$	20	10	<10	10
Cobalt, total as Co	$\mu\text{g}/\text{L}$	<1	<1	<1	<1
Copper, total as Cu	$\mu\text{g}/\text{L}$	2	5	6	3
Iron, total as Fe	$\mu\text{g}/\text{L}$	530	46	300	26
Iron, dissolved as Fe	$\mu\text{g}/\text{L}$	170	46	14	26
Lead, total as Pb	$\mu\text{g}/\text{L}$	<1	<1	9	2
Lithium, total as Li	$\mu\text{g}/\text{L}$	<10	<10	<10	<10
Manganese, total as Mn	$\mu\text{g}/\text{L}$	21	16	10	27
Manganese, dissolved as Mn	$\mu\text{g}/\text{L}$	21	16	2	27
Mercury, total as Hg	$\mu\text{g}/\text{L}$	<0.1	<0.1	<0.1	<0.1
Molybdenum, total as Mo	$\mu\text{g}/\text{L}$	<1	1	<1	<1
Nickel, total as Ni	$\mu\text{g}/\text{L}$	3	7	4	5
Selenium, total as Se	$\mu\text{g}/\text{L}$	<1	<1	<1	<1
Silver, total as Ag	$\mu\text{g}/\text{L}$	<1	<1	<1	<1
Zinc, total as Zn	$\mu\text{g}/\text{L}$	30	530	140	20



**Figure 9.** Western Island Group, Chuuk State, Federated States of Micronesia.

## Pollap Island

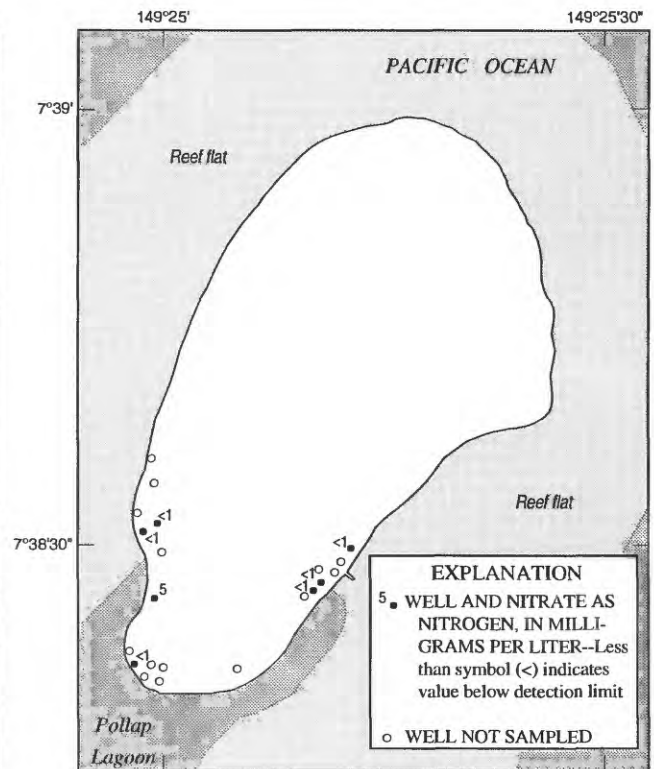
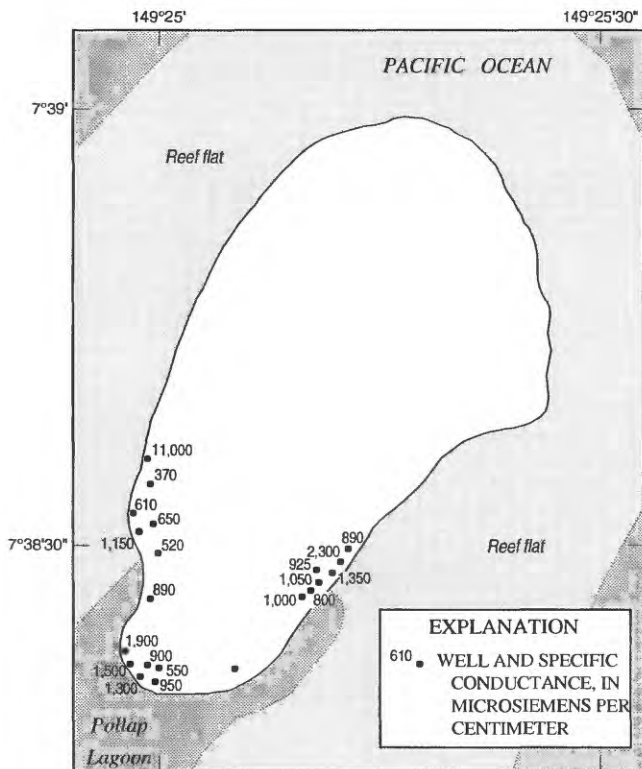
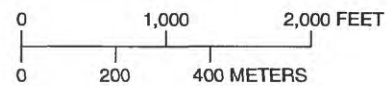
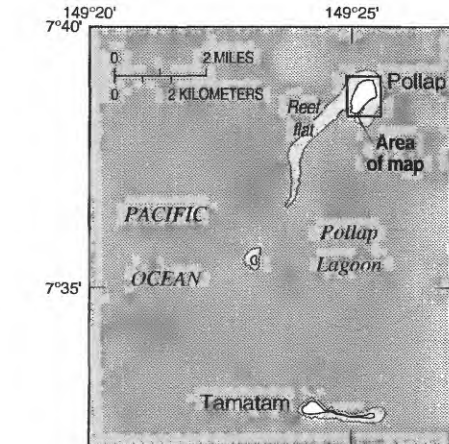
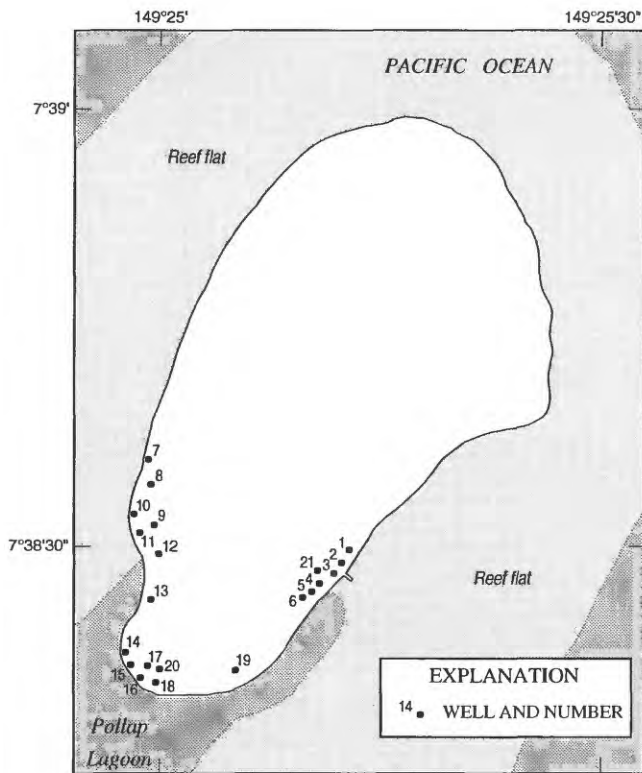
The population of Pollap Island at Pollap Atoll is about 432 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Pollap Island are shown in figure 10. Selected physical and water-quality data for the 21 dug wells sampled are given in table 2. The mean specific conductance for water from 21 wells was 1,450  $\mu\text{S}/\text{cm}$

and ranged from 370 to 10,000  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from 3 of the 21 wells sampled (wells 2, 7, and 14) exceeded the WHO (1984) guideline for chloride. Seven of the 21 wells sampled were field tested for nitrate concentration. Water from 6 of the 7 wells tested had nitrate concentrations of less than 1 mg/L (as N). Water from well 13 had nitrate concentrations of 5 mg/L (as N).

**Table 2.** Selected physical and water-quality data from dug wells, February 4 and 6, 1984, Pollap Island, Pollap Atoll, Western Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Simon	26.5	890	6.8	--	<1	
2	Kuto	26.5	2,300	--	--	--	
3	Seles	26	1,350	7.1	--	--	
4	Marasel	27	1,050	6.5	--	<1	
5	Roman	26.5	800	6.7	--	<1	
6	Francisca	27	1,000	6.6	--	--	
7	Titus	--	10,000	--	3,100	--	
8	Bernard	26.5	370	6.9	14	--	
9	Oscar	27	650	6.7	--	<1	
10	Fapian	28	610	6.8	--	--	
11	Fermin	27	1,150	6.7	150	<1	Major ion and trace element sample.
12	Sio	27.5	520	6.9	--	--	
13	Sixto	27.5	890	6.8	--	5	
14	Erman	28	1,900	6.7	--	--	
15	Bius	27.5	1,500	6.8	--	<1	
16	Asisi	27	1,300	6.9	--	--	
17	Akape	27.5	900	6.7	--	--	
18	Sibas	27.5	950	--	--	--	
19	Lucio	27	850	--	--	--	
20	Akin	29	550	--	--	--	
21	Marasel	26.5	925	--	--	--	



**Figure 10.** Well locations, specific conductance, and nitrate concentrations for Pollap Island, Pollap Atoll, Western Island Group, Chuuk State, 1984.

## Tamatam Island

The population of Tamatam Island, Pollap Atoll is about 188 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Tamatam Island are shown in figure 11. Selected physical and water-quality data for the 5 dug wells sampled are given in table 3. The mean specific conductance for water from 5 wells was 1,510

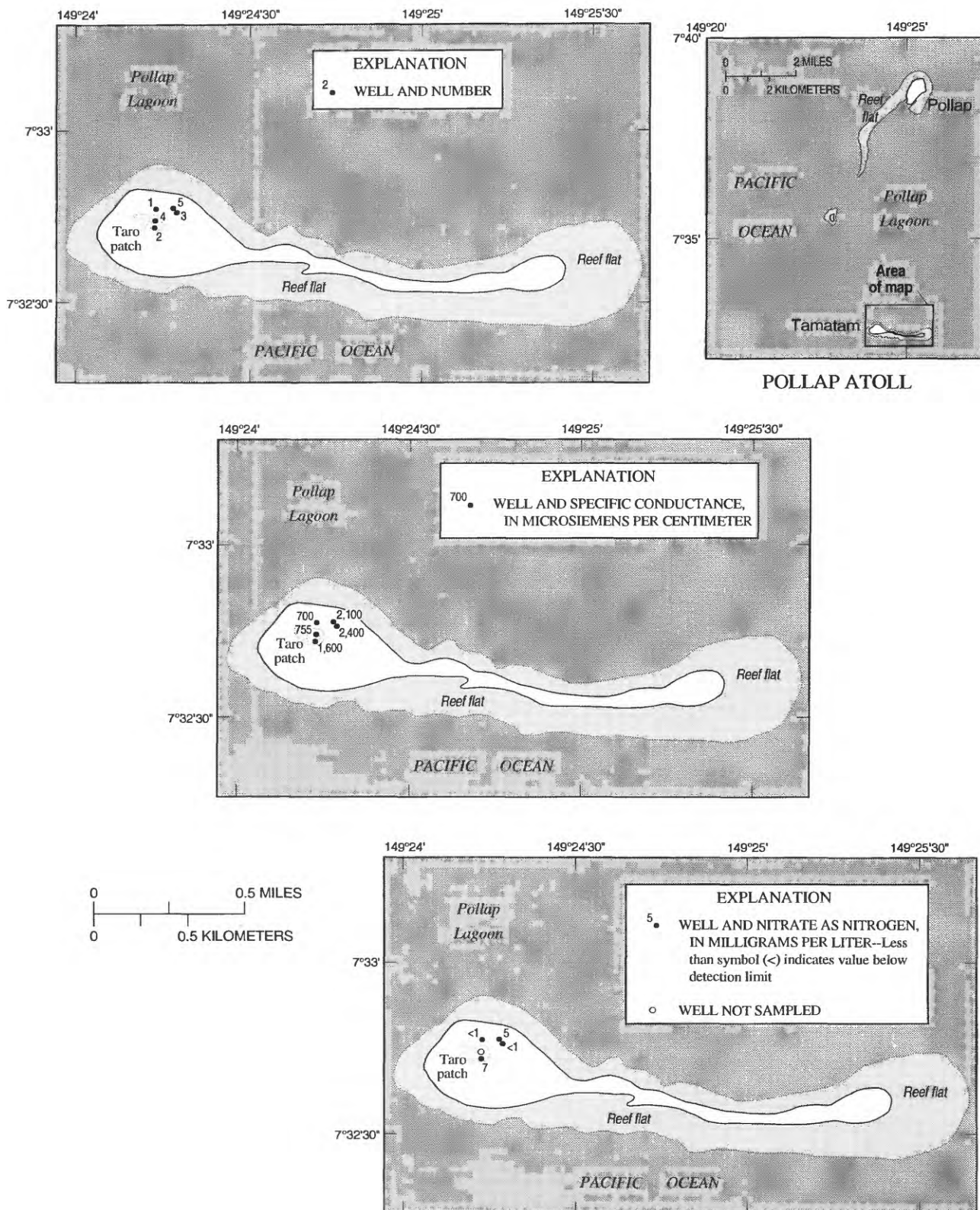
$\mu\text{S/cm}$  and ranged from 700 to 2,400  $\mu\text{S/cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from 3 of the 5 wells sampled (wells 2, 3, and 5) exceeded the WHO (1984) guideline for chloride. Four of the 5 wells sampled were field tested for nitrate concentration. Water from 2 of the 5 wells tested had nitrate concentrations of less than 1 mg/L (as N); the other two had concentrations of 5 and 7 mg/L (as N).

**Table 3.** Selected physical and water-quality data from dug wells, February 3, 1984, Tamatam Island, Pollap Atoll, Western Island Group

[°C, degrees Celsius;  $\mu\text{S/cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S/cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Rosanto	26.5	700	7.3	60	<1	Major ion and trace element sample.
2	Robert	27	1,600	7.2	240	7	
3	Kandito	27	2,400	7.0	530	<1	
4	not known	27	755	--	470	--	
5	not known	27.5	2,100	7.1	--	5	





**Figure 11.** Well locations, specific conductance, and nitrate concentrations for Tamatam Island, Pollap Atoll, Western Island Group, Chuuk State, 1984.

## Polowat Island

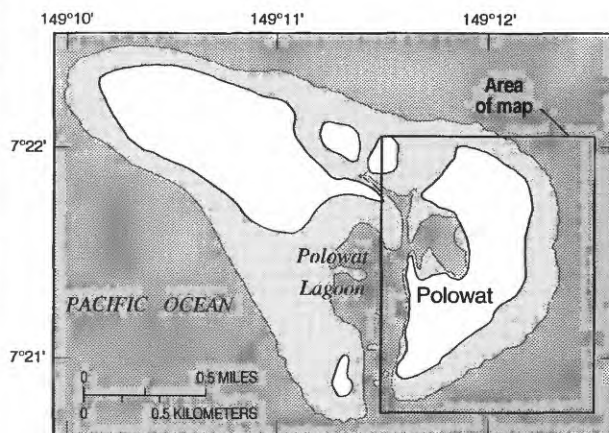
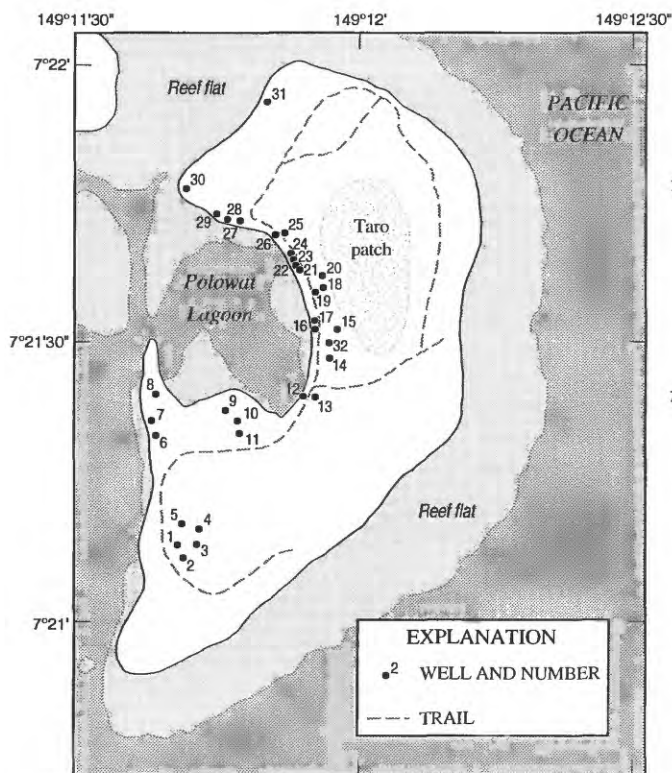
The population of Polowat Island, Polowat Atoll is about 495 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Polowat Island are shown in figure 12. Selected physical and water-quality data for the 31 dug wells, 1 driven well, and 1 taro patch site sampled are given in table 4. The mean specific conductance for

water from 32 wells was 790  $\mu\text{S}/\text{cm}$  and ranged from 270 to 1,500  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, none of the well waters sampled exceeded the WHO (1984) guideline for chloride. Five of the 32 wells and the 1 taro patch site sampled were field tested for nitrate concentration. Water from all 5 wells and the 1 taro patch site had nitrate concentrations of less than 1 mg/L (as N).

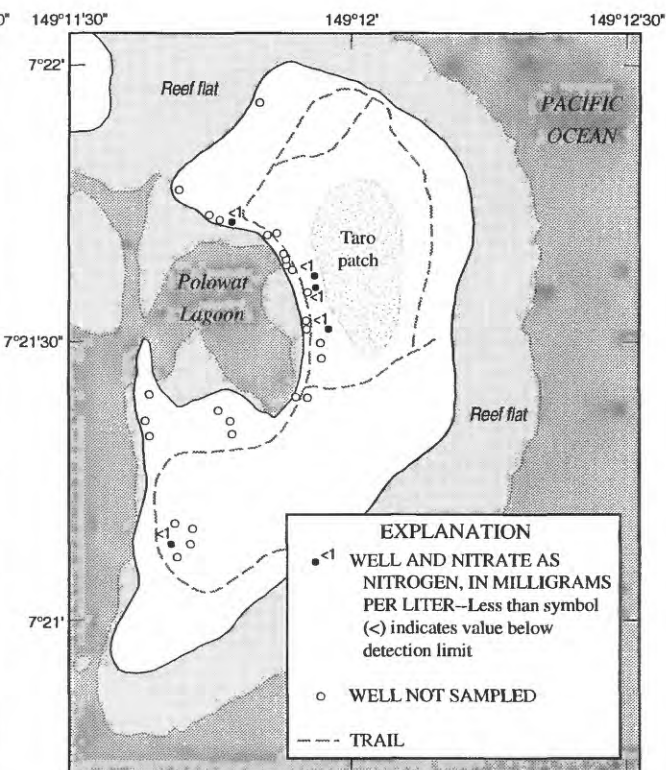
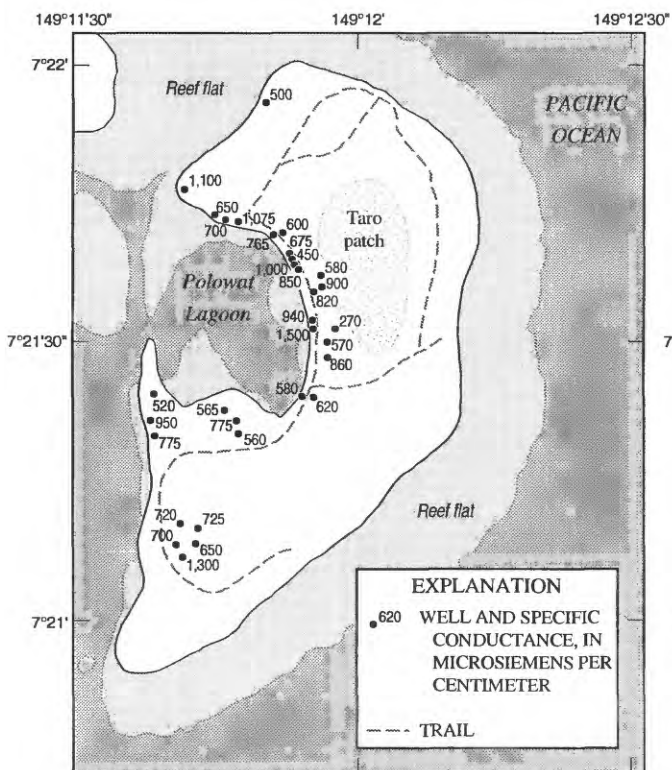
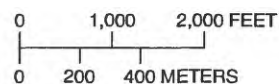
**Table 4.** Selected physical and water-quality data from dug and driven wells and taro patch, January 30–31, 1984, Polowat Island, Polowat Atoll, Western Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Lodis-Masair	26	700	7.2	--	<1	
2	Tilmuar	26	1,350	7.1	--	--	
3	Bisaln	27	650	7.1	--	--	
4	Ango	27	725	7.3	--	--	
5	Aluka	26	720	7.3	--	--	
6	Aisou	25	775	6.9	--	--	
7	Angkel	25	950	7.2	--	--	
8	Tidios	26	520	7.3	--	--	
9	Rabuy	26	565	--	--	--	
10	Tiduis	26.5	775	--	--	--	
11	Soim	25.5	560	--	16	--	
12	Rosin	25	580	--	--	--	
13	Ochoman	26.5	620	--	--	--	
14	Yoichi	26.5	860	--	--	--	
15	Serepei	26	270	--	24	<1	
16	Fapian	26.5	1,500	--	200	--	
17	Lasin	26	940	--	--	--	
18	Libokun	26.5	900	--	--	<1	
19	Iper	25.5	820	--	--	--	
20	Urupak	26	580	--	--	<1	
21	Pitin	26	850	--	--	--	
22	Aitel	26	1,000	--	--	--	
23	Sour	27	1,450	--	--	--	
24	Yokichi	27	675	--	--	--	
25	Masmino	26.5	600	--	--	--	
26	Pieiluk	26.5	765	--	--	--	
27	Anasy	27	1,075	--	--	<1	
28	Malipy	28	700	--	--	--	
29	Isaocy	27	650	--	19	--	
30	Engi	27	1,100	--	--	--	
31	not known	27	500	--	--	--	
32	School	27.5	570	6.4	6	--	Major ion and trace element sample.
Taro patch		27.7	3,500	7.3	--	<1	



POLOWAT ATOLL



**Figure 12.** Well locations, specific conductance, and nitrate concentrations for Polowat Island, Polowat Atoll, Western Island Group, Chuuk State, 1984.



## Houk Island

The population of Houk Island is about 214 (Truk State Office of Planning and Statistics, 1981). Well locations, miscellaneous sampling sites, specific conductance, and nitrate concentrations for Houk Island are shown in figure 13. Selected physical and water-quality data for the 7 dug wells and 2 miscellaneous sites sampled are given in table 5. The mean specific conductance for water from 7 wells was 700  $\mu\text{S}/\text{cm}$  and ranged from 390 to 1,100  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data,

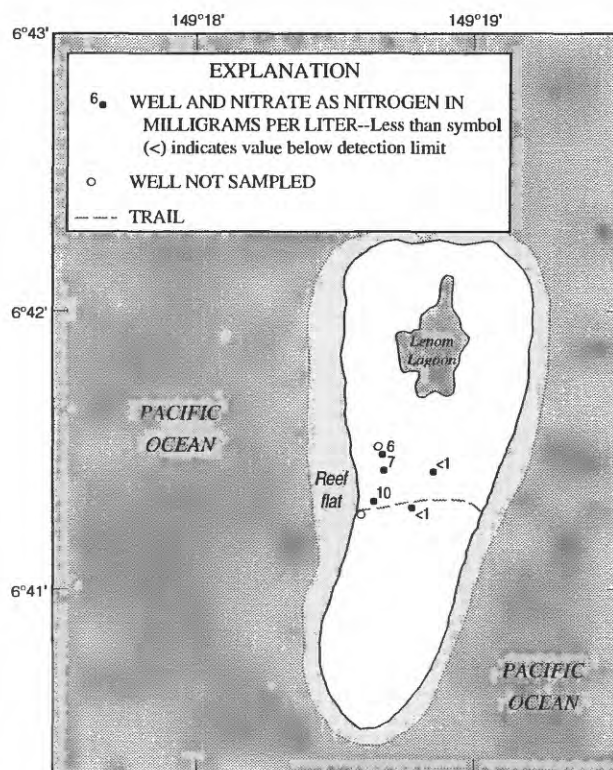
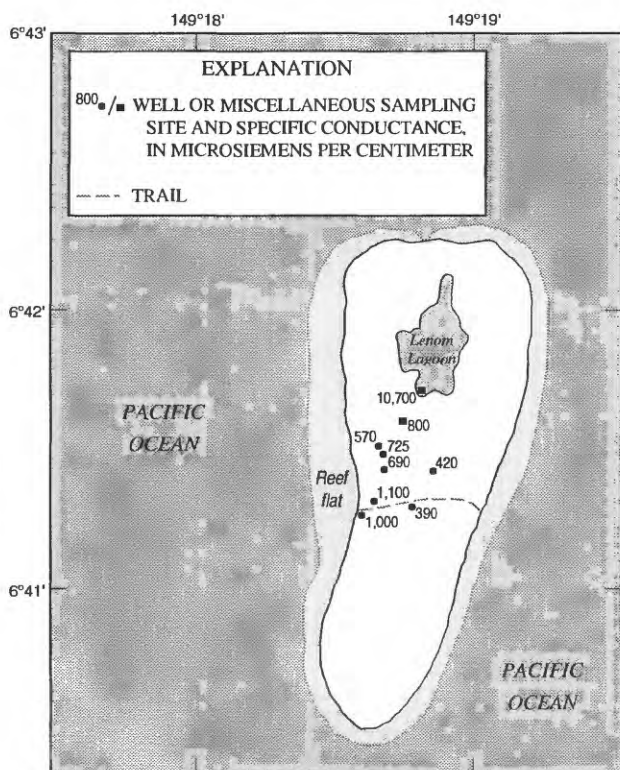
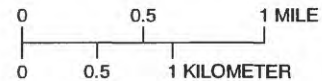
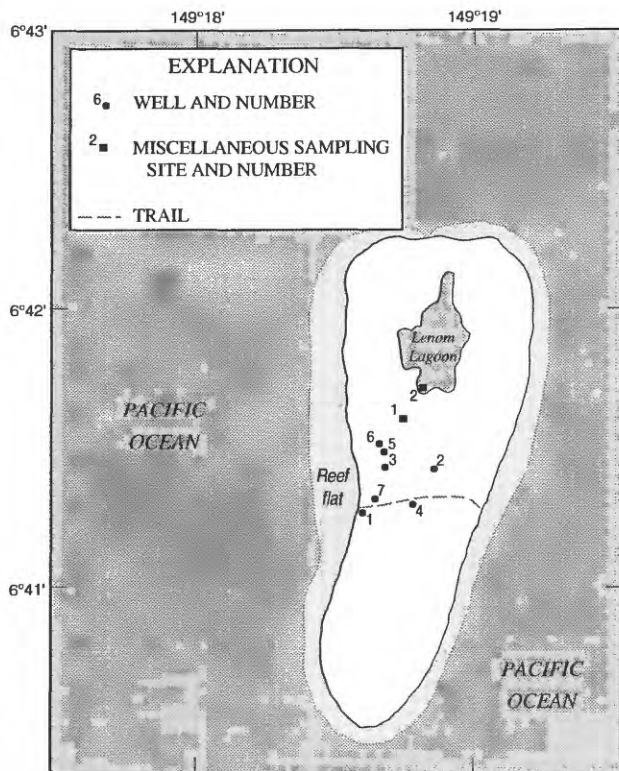
none of the well waters sampled exceeded the WHO (1984) guideline for chloride. The highest measured value of specific conductance was for a water sample collected from Lenom Lagoon (10,700  $\mu\text{S}/\text{cm}$ ). Five of the 7 wells sampled were field tested for nitrate concentration. Water from 2 of the wells tested had nitrate concentrations of less than 1 mg/L (as N); the others had concentrations of 6, 7, and 10 mg/L (as N). A laboratory analysis of water from well 7 resulted in a nitrate plus nitrite concentration of 13 mg/L (as N) (table 1), which exceeds the WHO (1984) guideline for nitrate.

**Table 5.** Selected physical and water-quality data from dug wells and miscellaneous sampling sites, February 5, 1984, Houk Island, Polowat Atoll, Western Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no. or sampling site	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Lekin	27	1,000	7.3	--	--	
2	Ululanue	27	420	7.1	8	<1	
3	Sitow	27.5	690	7.0	--	7	
4	Leop	26.5	390	7.2	--	<1	
5	Sakio	27.5	700	7.1	28	6	
6	Lerop	27	570	7.1	--	--	
7	Chief Pei-ong	27.5	1,100	6.9	39	10	Major ion and trace element sample.
Miscellaneous site 1		26.5	500	--	--	--	
Miscellaneous site 2		28.5	10,700 <sup>1</sup>	--	3,400	--	

<sup>1</sup> Laboratory determination



**Figure 13.** Well locations, specific conductance, and nitrate concentrations for Houk Island, Western Island Group, Chuuk State, 1985.

## Namonweito Island Group

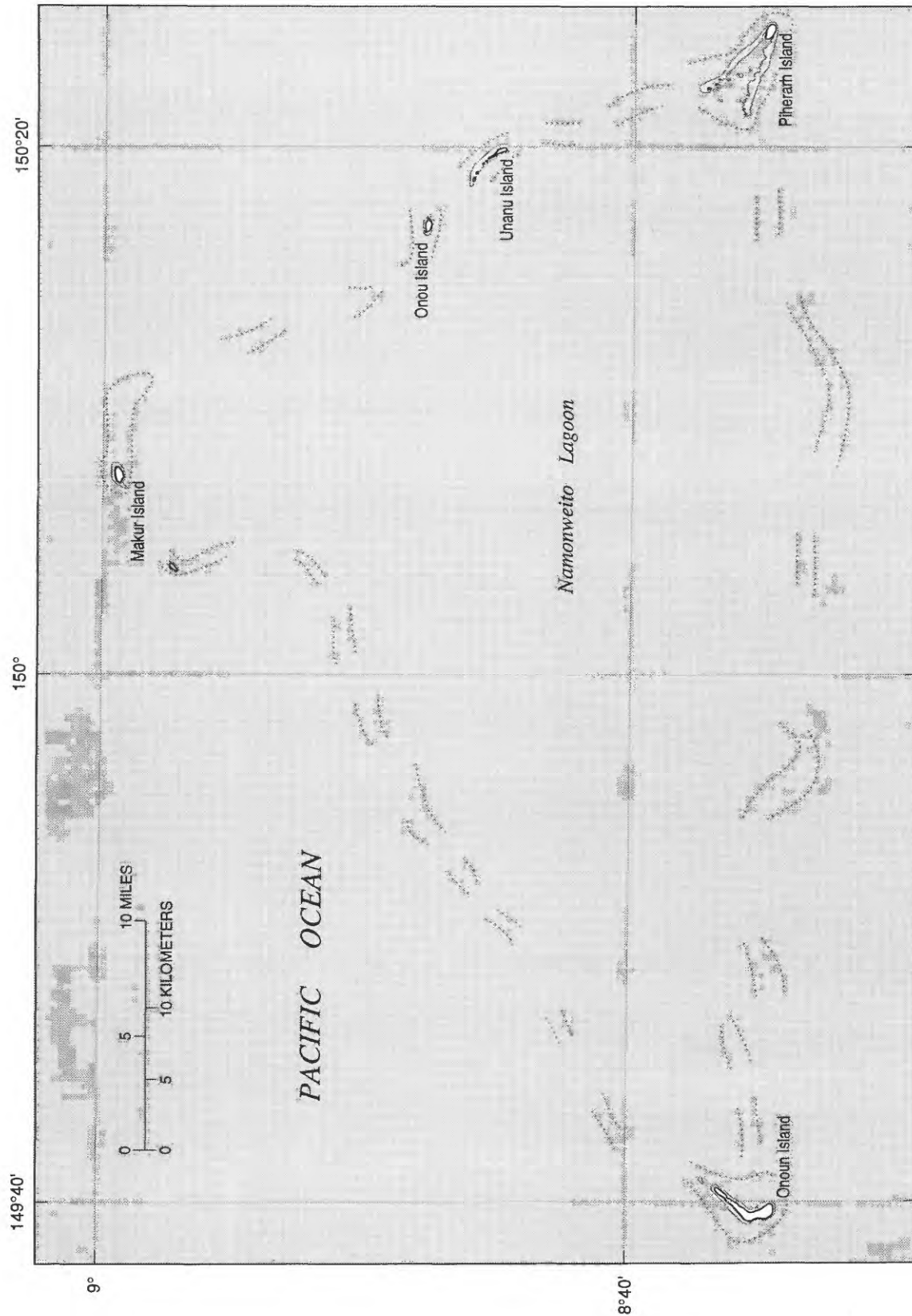
The inhabited islands of the Namonweito Island Group are Onoun, Makur, Onou, Unanu, and Piherarh Islands at Namonweito Atoll (fig. 14). These islands are about 160 mi northwest of the Chuuk Island Group. Mean values for specific conductance of ground water on each of the islands ranged from 1,070  $\mu\text{S}/\text{cm}$  on

Onoun Island to 6,750  $\mu\text{S}/\text{cm}$  on Onou Island. Field determinations for nitrate concentration of ground water ranged from less than 1 mg/L on Onoun and Unanu Islands to 15 mg/L on Onoun Island. Table 6 includes physical, major-ion, and trace-element data for selected wells in the Namonweito Island Group. Specific information for each of the islands is presented below.

**Table 6.** Physical, major ion, and trace element data for selected wells in the Piherarh and Onoun Islands, Namonweito Atoll Group, Chuuk State

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25°C; mg/L, milligrams per liter;  $\mu\text{g}/\text{L}$ , micrograms per liter;  $\text{CaCO}_3$ , calcium-carbonate; <, less than]

Property or constituent	Units	Piherarh well 5 03/21/84	Onoun well 1 03/23/84
Specific conductance . . . . .	$\mu\text{S}/\text{cm}$	950	1,750
pH. . . . .	units	6	7.8
Temperature . . . . .	°C	27.5	28.5
Hardness as $\text{CaCO}_3$ . . . . .	mg/L	390	390
Calcium, total as Ca . . . . .	mg/L	130	100
Magnesium, total as Mg. . . . .	mg/L	15	34
Sodium, total as Na . . . . .	mg/L	61	200
Potassium, total as K . . . . .	mg/L	13	25
Alkalinity, total as $\text{CaCO}_3$ . . . . .	mg/L	335	330
Sulfate, dissolved as $\text{SO}_4$ . . . . .	mg/L	22	65
Chloride, dissolved as Cl . . . . .	mg/L	100	320
Fluoride, total as F . . . . .	mg/L	0.2	0.4
Silica, dissolved as $\text{SiO}_2$ . . . . .	mg/L	1.4	7.6
Dissolved solids, calculated, sum of constituents . . . . .	mg/L	597	1,020
Aluminum, total as Al . . . . .	mg/L	30	30
Arsenic, total as As . . . . .	$\mu\text{g}/\text{L}$	<1	2
Barium, total as Ba. . . . .	$\mu\text{g}/\text{L}$	<100	<100
Beryllium, total as Be . . . . .	$\mu\text{g}/\text{L}$	<10	<10
Cadmium, total as Cd. . . . .	$\mu\text{g}/\text{L}$	<1	<1
Chromium, total as Cr . . . . .	$\mu\text{g}/\text{L}$	20	20
Cobalt, total as Co . . . . .	$\mu\text{g}/\text{L}$	<1	<1
Copper, total as Cu. . . . .	$\mu\text{g}/\text{L}$	2	6
Iron, total as Fe . . . . .	$\mu\text{g}/\text{L}$	19	50
Iron, dissolved as Fe . . . . .	$\mu\text{g}/\text{L}$	19	23
Lead, total as Pb. . . . .	$\mu\text{g}/\text{L}$	4	3
Lithium, total as Li. . . . .	$\mu\text{g}/\text{L}$	<10	10
Manganese, total as Mn . . . . .	$\mu\text{g}/\text{L}$	62	65
Manganese, dissolved as Mn . . . . .	$\mu\text{g}/\text{L}$	62	65
Mercury, total as Hg . . . . .	$\mu\text{g}/\text{L}$	0.1	<0.1
Molybdenum, total as Mo . . . . .	$\mu\text{g}/\text{L}$	<1	2
Nickel, total as Ni . . . . .	$\mu\text{g}/\text{L}$	<1	8
Selenium, total as Se . . . . .	$\mu\text{g}/\text{L}$	<1	<1
Silver, total as Ag. . . . .	$\mu\text{g}/\text{L}$	<1	<1
Zinc, total as Zn . . . . .	$\mu\text{g}/\text{L}$	10	140



**Figure 14.** Namonweito Island Group, Chuuk State, Federated States of Micronesia.

## Onoun Island

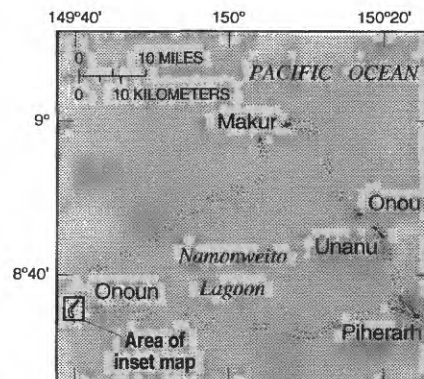
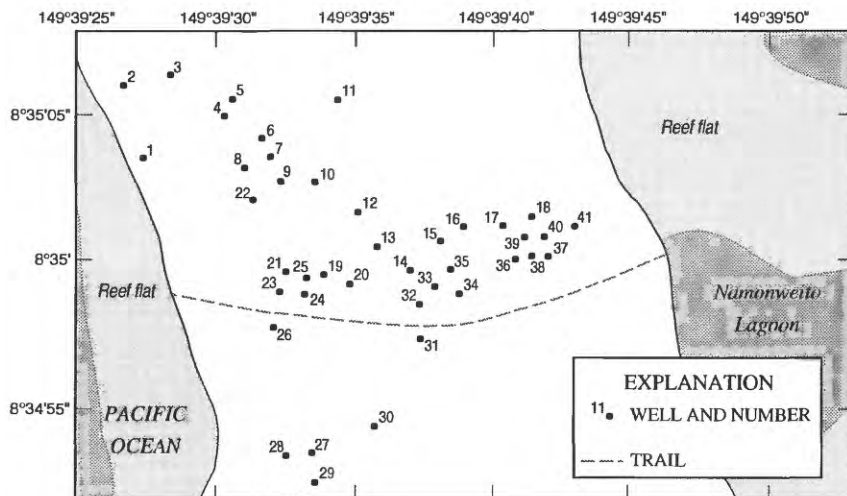
The population of Onoun Island, Namonweito Atoll is about 446 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Onoun Island are shown in figure 15. Selected physical and water-quality data for the 41 dug wells and 1 taro patch site sampled are given in table 7. The mean specific conductance for water from 41 wells was 1,070  $\mu\text{S}/\text{cm}$  and ranged from 335 to 1,750  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chlo-

ride concentrations from specific conductance data, water from 6 of the 41 wells sampled (wells 1, 3, 15, 17, 19, and 26) exceeded the WHO (1984) guideline for chloride. All 41 of the wells sampled were field tested for nitrate concentration. Water from about half of the wells tested had nitrate concentrations of less than 1 mg/L (as N); the remaining well waters had concentrations between 1 and 15 mg/L (as N). Two of these water samples (wells 1 and 3) exceeded the WHO (1984) guideline for nitrate.

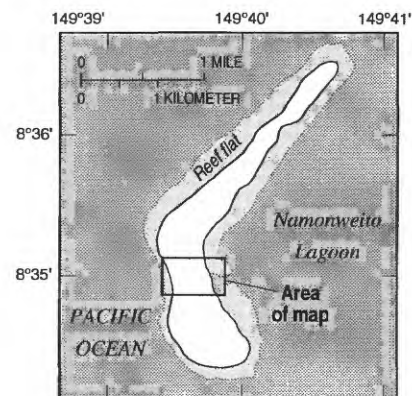
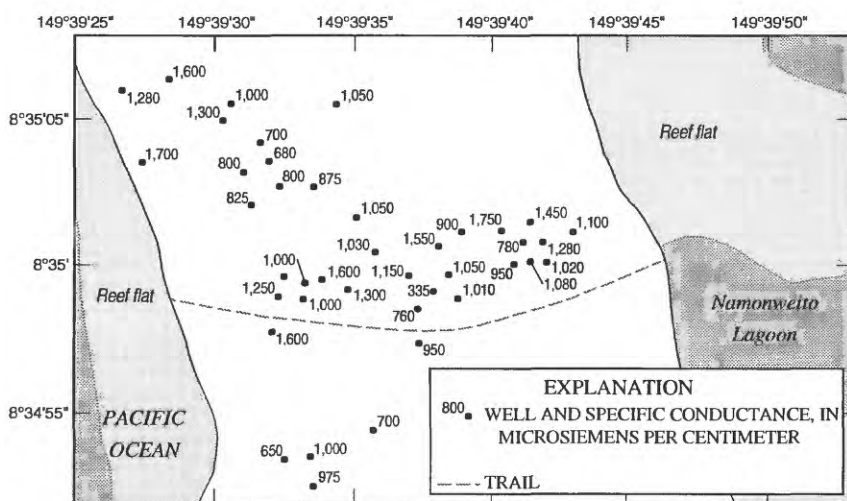
**Table 7.** Selected physical and water-quality data from dug wells and taro patch site, March 23, 1984, Onoun Island, Namonweito Atoll, Namonweito Island Group  
[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	High School (1)	27.5	1,700	--	320	11	Major ion and trace element sample
2	Ernes Smith	28	1,280	--	--	8	
3	High School (2)	26.5	1,600	--	--	15	
4	High School (3)	28	1,300	--	--	4	
5	High School (4)	28	1,000	--	--	3	
6	Kulas (1)	27.5	700	--	--	<1	
7	Kulas (2)	27.5	680	--	--	2	
8	Menas	27.5	800	--	--	7	
9	Felix	27	800	--	--	<1	
10	Fotomai	27	875	--	--	<1	
11	Alphanso	27.5	1,050	--	--	2	
12	Magar	28	1,050	--	--	4	
13	Keledo	27.5	1,030	--	--	4	
14	Passano	27.5	1,150	--	--	<1	
15	Kipier (1)	28	1,550	--	--	2	
16	Kipier (2)	27.5	900	--	--	<1	
17	Wan	27.5	1,750	--	--	<1	
18	Ersin	27.5	1,450	--	--	3	
19	Mateus	26.5	1,600	--	--	1	
20	Cox	27.5	1,300	--	100	10	
21	Philip	27	--	--	--	<1	
22	Konny	27.5	825	--	--	<1	
23	Anita	27.5	1,250	--	--	3	
24	Thomas	28	1,000	--	--	2	
25	Namichy	27	1,000	--	--	1	
26	Changy	27.5	1,600	--	--	7	
27	Caspar	27.5	1,000	--	--	1	
28	Jacky (1)	28	650	--	--	<1	
29	Jacky (2)	27.5	975	--	--	1	
30	Choring Rafial	28.5	700	--	--	<1	
31	Ogi Rafial	27.5	950	--	--	<1	
32	Simeon	28	760	--	--	<1	
33	Litong	27.5	335	--	21	<1	
34	Sixto	26.5	1,010	--	--	<1	
35	Robert	28	1,050	--	--	<1	
36	Tanaka	27.5	950	--	--	<1	
37	Solomon	27	1,020	--	--	<1	
38	Leon (1)	28	1,080	--	--	<1	
39	Leon (2)	28	780	--	--	<1	
40	Rubano (1)	28	1,280	--	--	2	
41	Rubano (2)	27	1,100	--	--	1	
	Taro patch	28	800	--	--	--	

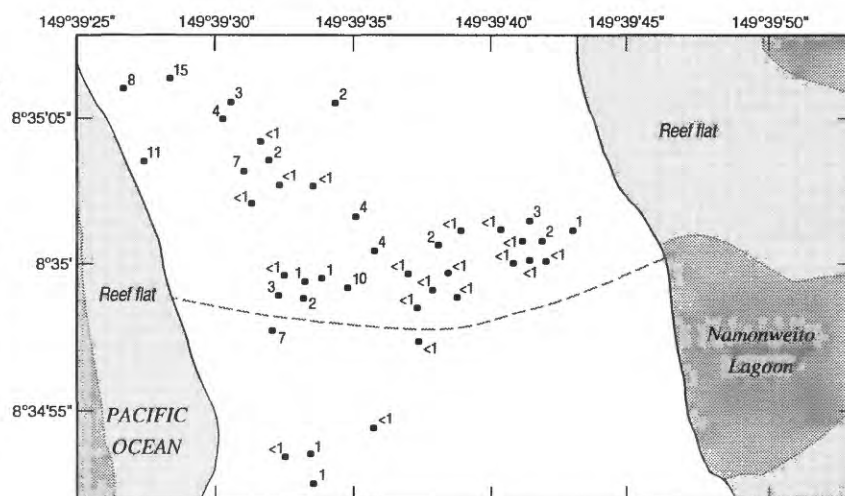
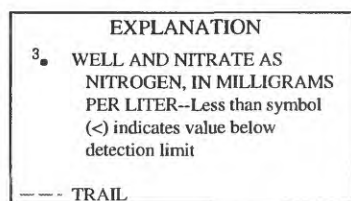
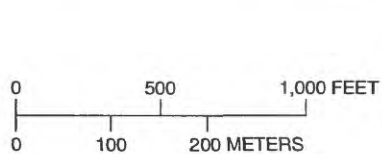




NAMONWEITO ATOLL



INSET MAP OF ONOUN ISLAND



**Figure 15.** Well locations, specific conductance, and nitrate concentrations for Onoun Island, Namonweito Atoll, Namonweito Island Group, Chuuk State, 1984.

## Makur Island

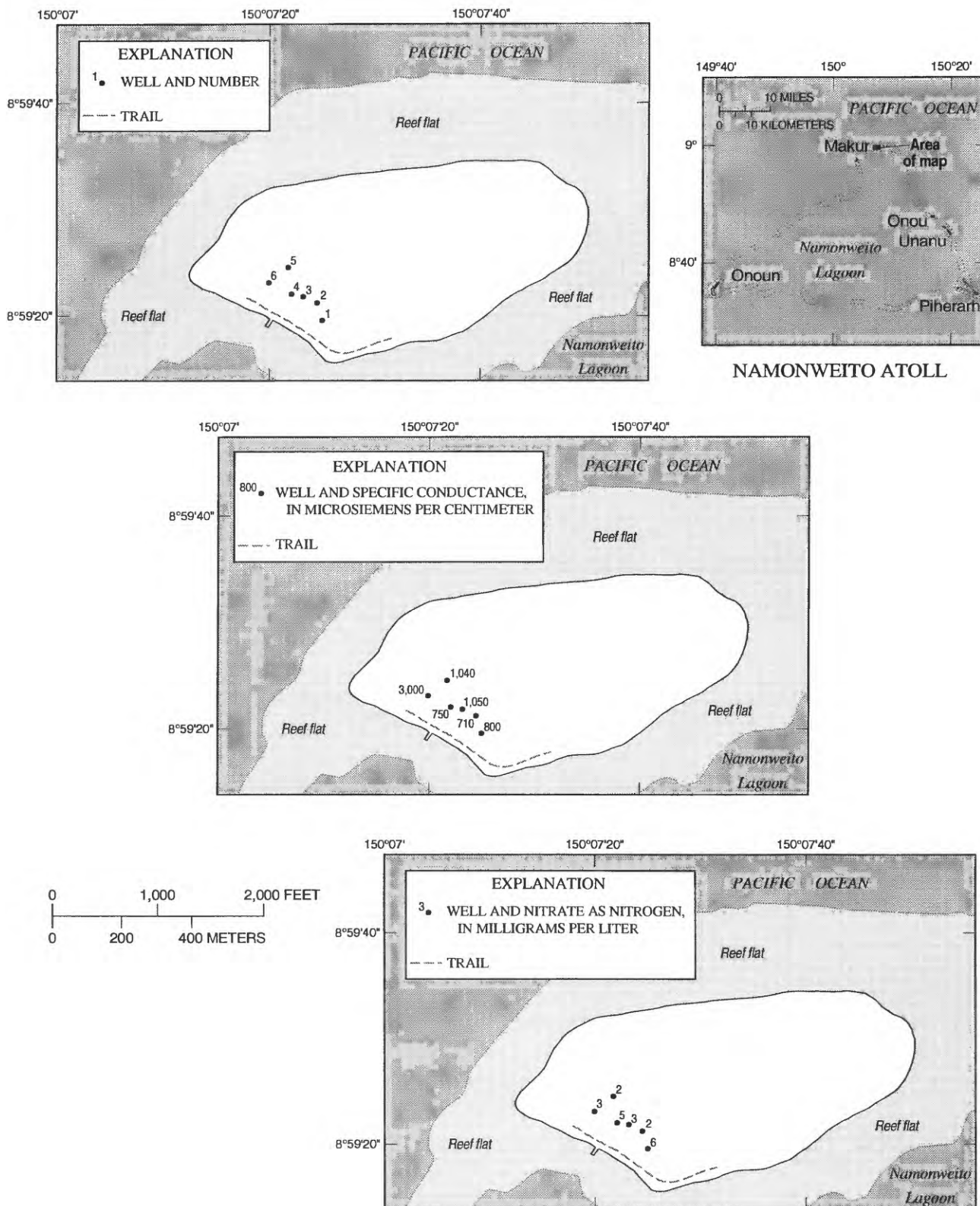
The population of Makur Island, Namonweito Atoll is about 97 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Makur Island are shown in figure 16. Selected physical and water-quality data for the 6 dug wells sampled are given in table 8. The

mean specific conductance for water from 6 wells was 1,220  $\mu\text{S}/\text{cm}$  and ranged from 710 to 3,000  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentration from specific conductance data, water from 1 of the 6 wells sampled (well number 6) exceeded the WHO (1984) guideline for chloride. All 6 of the wells sampled were field tested for nitrate concentration and yielded values ranging from 2 to 6 mg/L (as N).

**Table 8.** Selected physical and water-quality data from dug wells, March 18, 1984, Makur Island, Namonweito Atoll, Namonweito Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)
1	Anton	27.5	800	--	--	6
2	Yasuo Smith	28.5	710	--	--	2
3	Public well	27.5	1,050	--	--	3
4	Ananias	28	750	--	--	5
5	Teresa	28.5	1,040	--	--	2
6	Osey Tom	27	3,000	--	--	3



**Figure 16.** Well locations, specific conductance, and nitrate concentrations for Makur Island, Namonweito Atoll, Namonweito Island Group, Chuuk State, 1984.



## Onou Island

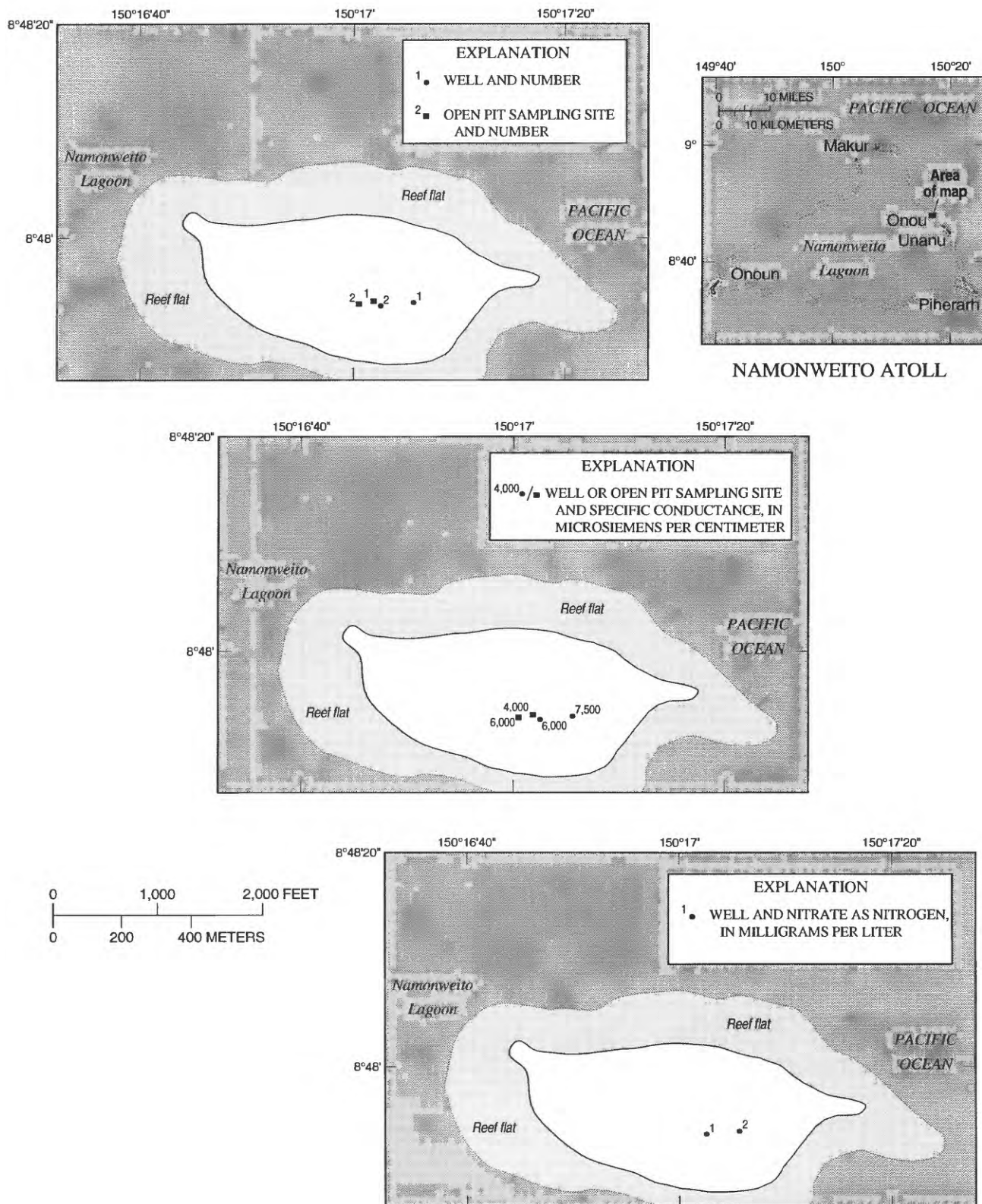
The population of Onou Island, Namonweito Atoll is about 59 (Truk State Office of Planning and Statistics, 1981). Well locations, sampling sites, specific conductance, and nitrate concentrations for Onou Island are shown in figure 17. Selected physical and water-quality data for the 2 dug wells and 2 open pit sites sampled are

given in table 9. The mean specific conductance for water from 2 wells was 6,750  $\mu\text{S}/\text{cm}$  and ranged from 6,000 to 7,500  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from both wells sampled exceeded the WHO (1984) guideline for chloride. Both of the wells sampled were field tested for nitrate concentration and yielded values of 1 and 2 mg/L (as N).

**Table 9.** Selected physical and water-quality data from dug wells and miscellaneous sampling sites, March 19, 1984, Onou Island, Namonweito Atoll Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured]

Well no. or sampling site	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)
1	Public well	27.5	7,500	--	2,000	2
2	Public well	27.5	6,000	--	--	1
Open pit 1		29	4,000	--	--	--
Open pit 2		27.5	6,000	--	--	--



**Figure 17.** Well locations, specific conductance, and nitrate concentrations for Onou Island, Namonweito Atoll, Namonweito Island Group, Chuuk State, 1984.

## Unanu Island

The population of Unanu Island, Namonweito Atoll is about 79 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Unanu Island are shown in figure 18. Selected physical and water-quality data for the 7 dug wells and 1 driven well sampled are given in table 10. The mean specific conductance for water from

8 wells was 3,340  $\mu\text{S}/\text{cm}$  and ranged from 2,000 to 6,000  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, all of these samples exceed the WHO (1984) guideline for chloride. Six of the 8 wells sampled were field tested for nitrate concentration. Water from 2 of the wells tested had nitrate concentrations of less than 1 mg/L (as N). Nitrate concentrations for water from the other 4 wells tested ranged from 1 to 5 mg/L (as N).

**Table 10.** Selected physical and water-quality data from dug and driven wells, March 20, 1984, Unanu Island, Namonweito Atoll, Namonweito Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Tara	28	6,000	--	--	1	
2	Wan	27.5	3,750	--	--	<1	
3	Osei	28	3,500	--	--	--	
4	Lucas	27	3,000	--	--	5	
5	Public well	27.5	2,000	--	--	1	
6	Raimore	27	2,100	--	--	--	
7	Ananias	27	2,900	--	--	4	
8	Chief	26	3,500	--	--	<1	Installed 1 1/4" well point with hand pump.



## Piherarh Island

The population of Piherarh Island, Namonweito Atoll is about 118 (Truk State Office of Planning and Statistics, 1981). Well locations, sampling sites, specific conductance, and nitrate concentrations for Piherarh Island are shown in figure 19. Selected physical and water-quality data for the 17 dug wells and 1 taro patch site sampled are given in table 11. The mean specific

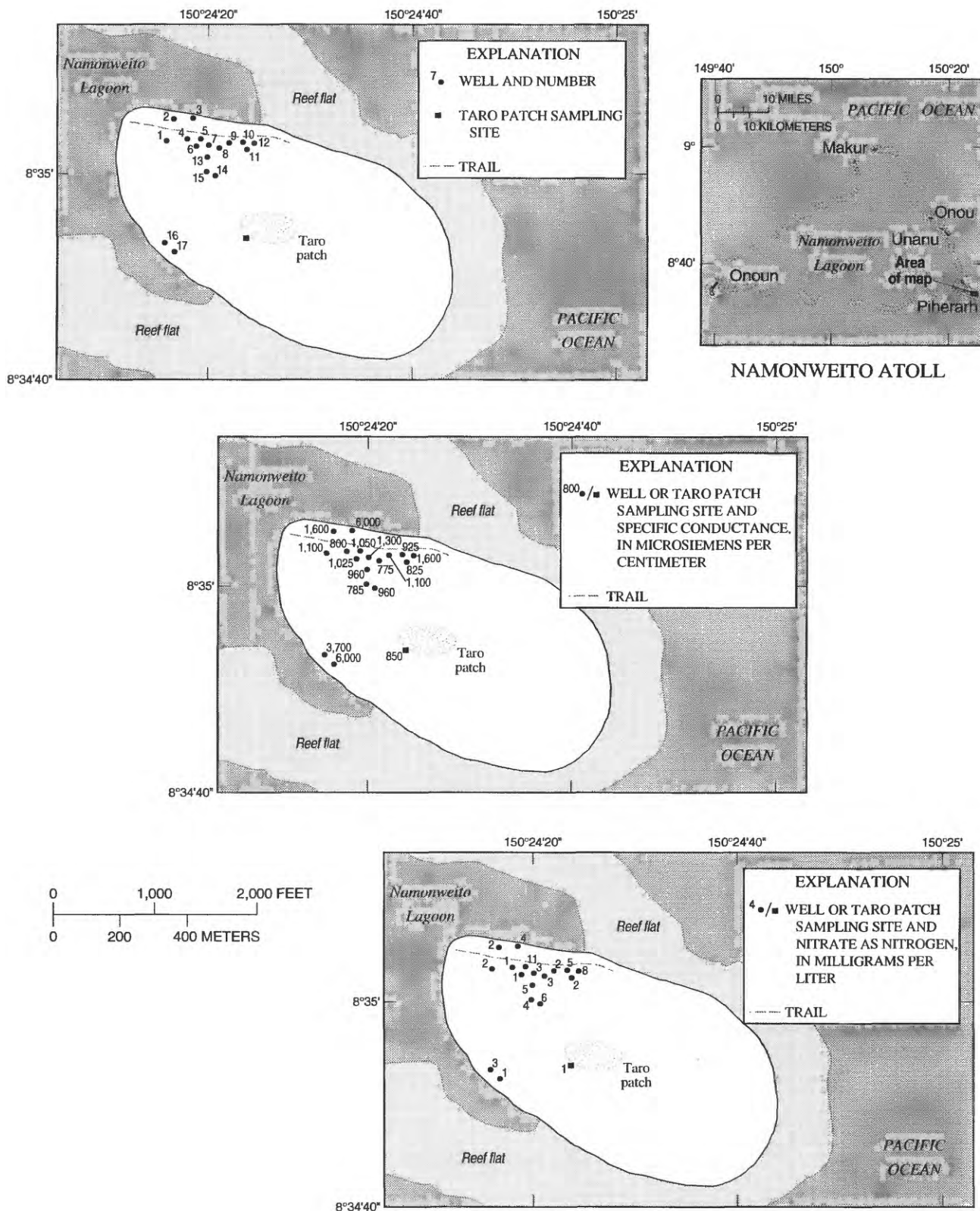
conductance for water from 17 wells was 1,790  $\mu\text{S}/\text{cm}$  and ranged from 775 to 6,000  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from 5 of the 17 wells (wells 2, 3, 12, 16, and 17) exceeded the WHO (1984) guideline for chloride. All 17 of the wells sampled were field tested for nitrate concentration, and yielded values ranging from 1 to 11 mg/L (as N). Water from well 5 exceeded the WHO (1984) guideline for nitrate.

**Table 11.** Selected physical and water-quality data from dug wells and taro patch site, March 21, 1984, Piherarh Island, Namonweito Atoll, Namonweito Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured]

Well no. or sampling site	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Bius	27.5	1,100	--	--	2	
2	Samuel	27	1,600	--	--	2	
3	Maximino (1)	27	6,000	--	--	4	
4	Maximino (2)	27.5	800	--	--	1	
5	Richy	27.5	950	6.8	100	11	Major ion and trace element sample
6	Sikan	27	1,020	--	--	1	
7	Nori	27.5	1,300	--	--	3	
8	Puruno	27.5	775	--	--	3	
9	Poki	27.5	1,100	--	--	2	
10	Mateus	27	925	--	--	5	
11	Luciano	27.5	825	--	--	2	
12	Eramus	27	1,600	--	--	8	
13	Yowanis	27	960	--	--	5	
14	Emere	27	960	--	--	2	
15	Teruo (1)	27	785	--	--	4	
16	Teruo (2)	28	3,700	--	--	3	
17	Pisente	27.5	6,000	--	--	1	
Taro patch		28	850	--	--	1	





**Figure 19.** Well locations, specific conductance, and nitrate concentrations for Piherarh Island, Namonweito Atoll, Namonweito Island Group, Chuuk State, 1984.

## Hall Island Group

The inhabited islands of the Hall Island Group are Nomwin and Fananu Islands at Nomwin Atoll, and Murilo and Ruo Islands at Murilo Atoll (fig. 20). These islands are about 80 mi north of the Chuuk Island Group. Mean values for specific conductance of ground water on each of the islands range from 1,120  $\mu\text{S}/\text{cm}$  on

Murilo Island to 2,060  $\mu\text{S}/\text{cm}$  on Fananu Island. Field determinations for nitrate concentration of ground water ranged from less than 1 mg/L (as N) at selected sites on all islands to 18 mg/L (as N) on Nomwin Island. Table 12 includes physical, major-ion, and trace-element data for selected wells in the Hall Island Group. Specific information for each of the islands is presented below.

**Table 12.** Physical, major ion, and trace element data for selected wells in the Hall Island Group, Chuuk State

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25°C; mg/L, milligrams per liter;  $\mu\text{g}/\text{L}$ , micrograms per liter;  $\text{CaCO}_3$ , calcium-carbonate; --, not measured; <, less than]

Property or constituent	Units	Nomwin well 2 03/16/84	Fananu well 6 03/16/84	Murilo well 14 03/04/84	Ruo well 4 03/04/84
Specific conductance	$\mu\text{S}/\text{cm}$	1,900	4,000	975	1,550
pH	units	6.9	6.9	7.1	6.7
Temperature	°C	28.0	27.5	27.0	27.0
Hardness as $\text{CaCO}_3$	mg/L	500	660	370	500
Calcium, total as Ca	mg/L	140	140	120	150
Magnesium, total as Mg	mg/L	37	75	18	30
Sodium, total as Na	mg/L	160	490	63	140
Potassium, total as K	mg/L	71	20	2.7	7.8
Alkalinity, total as $\text{CaCO}_3$	mg/L	485	366	358	484
Sulfate, dissolved as $\text{SO}_4$	mg/L	63	150	20	71
Chloride, dissolved as Cl	mg/L	260	930	110	180
Fluoride, total as F	mg/L	0.4	0.3	0.6	0.2
Silica, dissolved as $\text{SiO}_2$	mg/L	5.2	2.4	4.1	6.5
Dissolved solids, calculated, sum of constituents	mg/L	1,130	2,040	554	877
Aluminum, total as Al	mg/L	40	30	30	20
Arsenic, total as As	$\mu\text{g}/\text{L}$	2	1	<1	4
Barium, total as Ba	$\mu\text{g}/\text{L}$	<100	<100	<100	<100
Beryllium, total as Be	$\mu\text{g}/\text{L}$	<10	<10	<10	<10
Cadmium, total as Cd	$\mu\text{g}/\text{L}$	<1	<1	<1	3
Chromium, total as Cr	$\mu\text{g}/\text{L}$	20	20	<10	10
Cobalt, total as Co	$\mu\text{g}/\text{L}$	<1	<1	1	<1
Copper, total as Cu	$\mu\text{g}/\text{L}$	6	2	2	5
Iron, total as Fe	$\mu\text{g}/\text{L}$	100	80	160	80
Iron, dissolved as Fe	$\mu\text{g}/\text{L}$	59	80	52	30
Lead, total as Pb	$\mu\text{g}/\text{L}$	2	<1	<1	<1
Lithium, total as Li	$\mu\text{g}/\text{L}$	<10	10	<10	<10
Manganese, total as Mn	$\mu\text{g}/\text{L}$	62	130	10	34
Manganese, dissolved as Mn	$\mu\text{g}/\text{L}$	62	130	--	34
Mercury, total as Hg	$\mu\text{g}/\text{L}$	0.1	0.1	<0.1	<0.1
Molybdenum, total as Mo	m/L	1	<1	<1	<1
Nickel, total as N	$\mu\text{g}/\text{L}$	2	<1	3	4
Selenium, total as Se	$\mu\text{g}/\text{L}$	<1	<1	<1	<1
Silver, total as Ag	$\mu\text{g}/\text{L}$	<1	<1	<1	<1
Zinc, total as Zn	$\mu\text{g}/\text{L}$	20	30	20	40

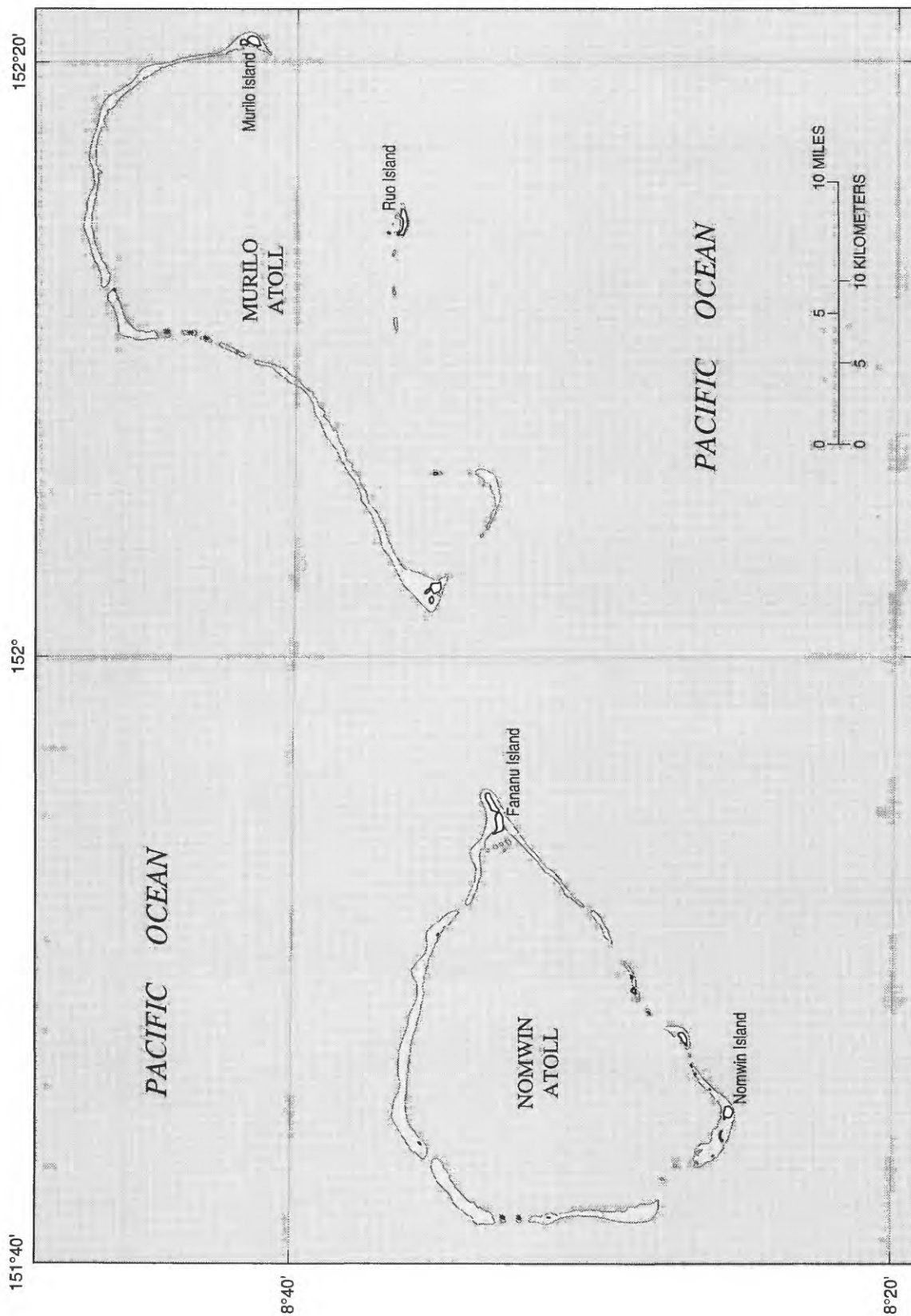


Figure 20. Hall Island Group, Chuuk State, Federated States of Micronesia.

## Nomwin Island

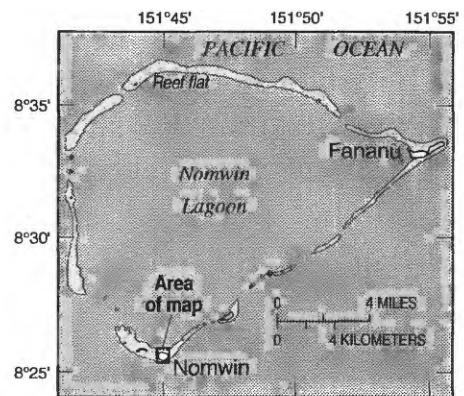
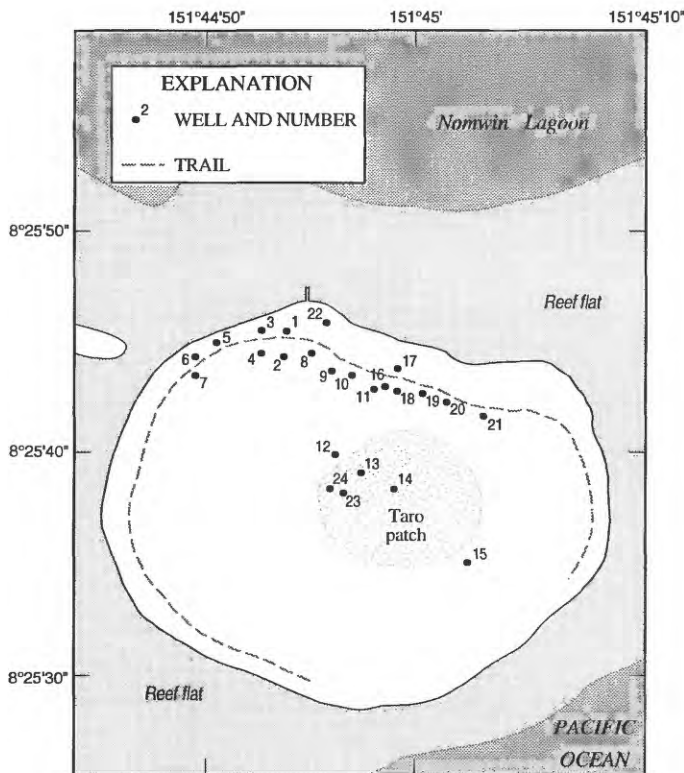
The population of Nomwin Island at Nomwin Atoll is about 324 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Nomwin Island are shown in figure 21. Selected physical and water-quality data for the 24 dug wells sampled are given in table 13. The mean specific conductance for water from 24 wells was 1,210  $\mu\text{S}/\text{cm}$  and ranged from 580 to 2,700  $\mu\text{S}/\text{cm}$ . On

the basis of the estimated chloride concentrations from specific conductance data, water from 4 of the 24 wells sampled (wells 2, 9, 21, and 22) exceeded the WHO (1984) guideline for chloride. Seventeen of the 24 wells sampled were field tested for nitrate concentration. Water from about half the wells tested had nitrate concentrations of less than 1 mg/L (as N); the others ranged from 2 to 18 mg/L (as N). Two of these water samples (wells 2 and 9) exceeded the WHO (1984) guideline for nitrate.

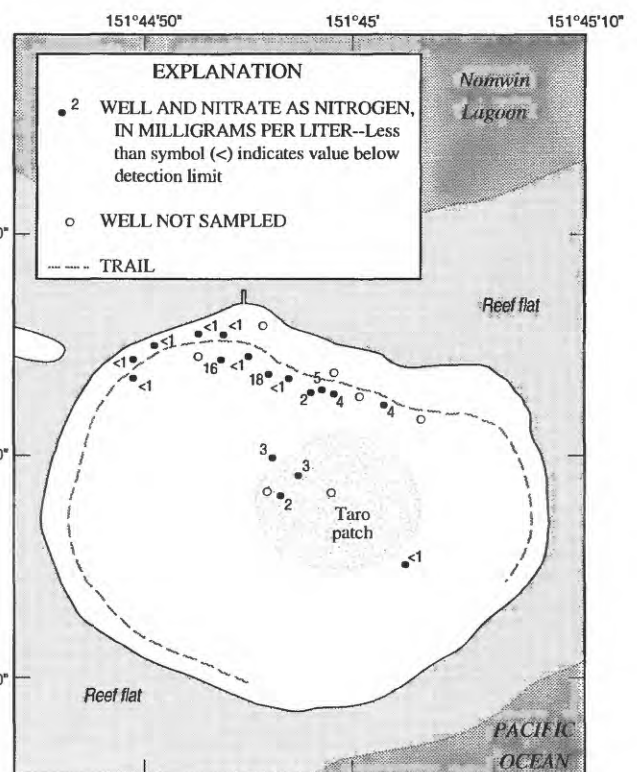
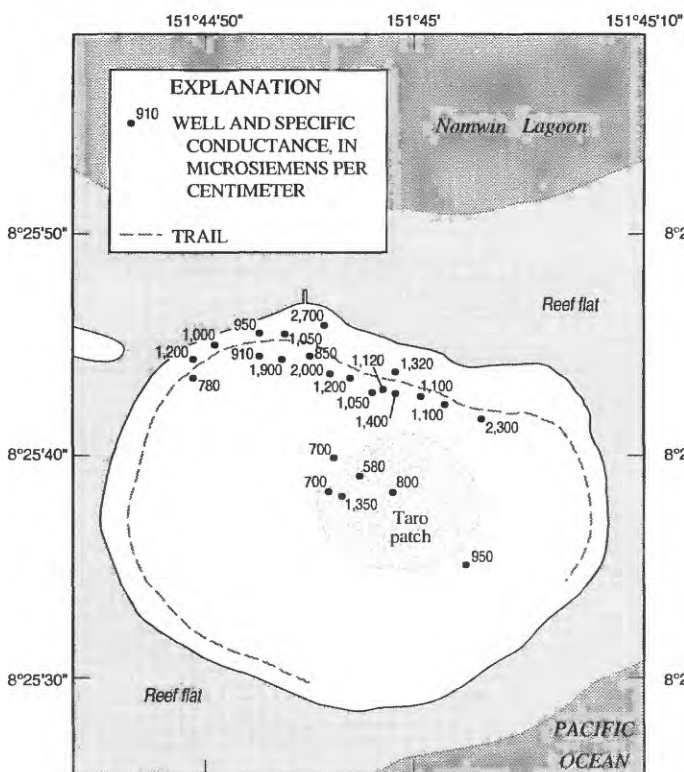
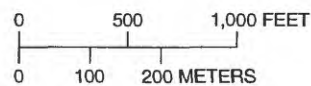
**Table 13.** Selected physical and water-quality data from dug wells, March 16, 1984, Nomwin Island, Nomwin Atoll, Hall Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Sokichy	27.5	1,050	--	--	<1	
2	Kotlip	28	1,900	6.9	260	16	Major ion and trace element sample
3	Pungopung	28	950	--	--	<1	
4	Nisuo	28	910	--	--	--	
5	Faniap	27	1,000	--	--	<1	
6	Snyder	28	1,200	--	--	<1	
7	Robert	27	780	--	--	<1	
8	Sadao	27	850	--	--	<1	
9	James	28	2,000	--	240	18	
10	Ruber	28	1,200	--	--	<1	
11	Lifang	27	1,050	--	--	2	
12	Secy	30	700	--	--	3	
13	Kisano	28.5	580	--	--	3	
14	Menchor	27.5	800	--	--	--	
15	Helmut	27	950	--	--	<1	
16	Koma	27.5	1,120	--	--	5	
17	Alita	27.5	1,320	--	--	--	
18	Pweta	27	1,400	--	--	4	
19	Fiman	27.5	1,100	--	--	--	
20	Kimuo	27	1,100	--	--	2	
21	Sopian	28	2,300	--	490	--	
22	Otto	27	2,700	--	--	--	
23	Malul	27.5	1,350	--	--	2	
24	Yoichy	29	700	--	--	--	



NOMWIN ATOLL



**Figure 21.** Well locations, specific conductance, and nitrate concentrations for Nomwin Island, Nomwin Atoll, Hall Island Group, Chuuk State, 1984.



## Fananu Island

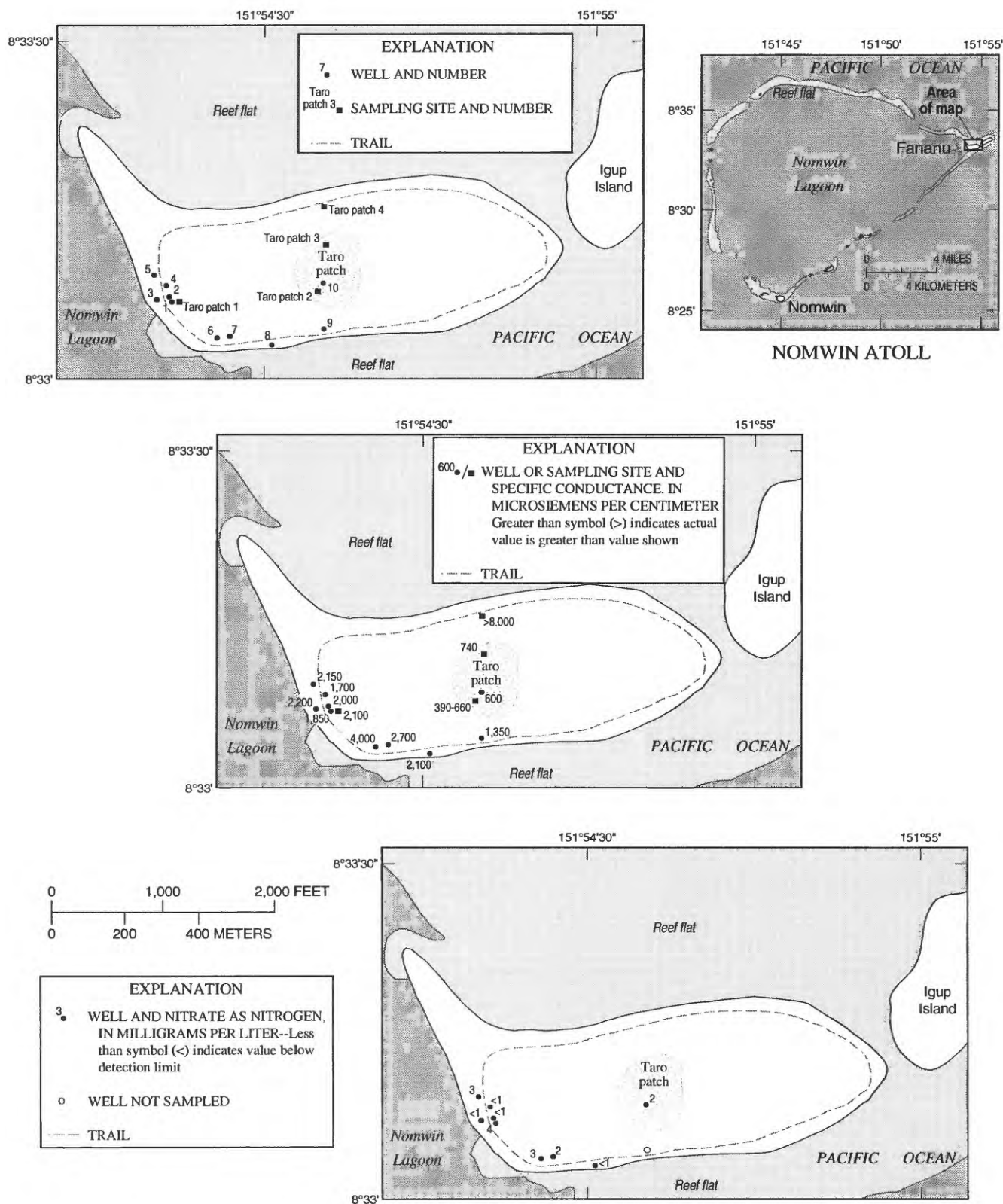
The population of Fananu Island at Nomwin Atoll is about 238 (Truk State Office of Planning and Statistics, 1981). Well locations, sampling sites, specific conductance, and nitrate concentrations for Fananu Island are shown in figure 22. Selected physical and water-quality data for the 10 dug wells and 4 taro patch sites sampled are given in table 14. The mean specific conductance for water from 10 wells was 2,060  $\mu\text{S}/\text{cm}$  and ranged from 600 to 4,000  $\mu\text{S}/\text{cm}$ . On the basis of the

estimated chloride concentrations from specific conductance data, water from 8 of the 10 wells sampled (wells 1 through 8) exceeded the WHO (1984) guideline for chloride. The highest measured value of specific conductance (>8,000  $\mu\text{S}/\text{cm}$ ) was for water collected from a small taro patch near the north shore of the island. Nine of the 10 wells sampled were field tested for nitrate concentration, and about half the water samples had values less than 1 mg/L (as N); the others ranged from 2 to 4 mg/L (as N).

**Table 14.** Selected physical and water-quality data from dug wells and taro patch sites, March 16, 1984, Fananu Island, Nomwin Atoll, Hall Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than; >, greater than]

Well no. or sam- pling site	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Abel	26.5	1,850	--	--	4	
2	Naruo	26.5	2,000	--	--	<1	
3	Sipura	26	2,200	--	--	<1	
4	Sona	27	1,700	--	--	<1	
5	Sopi	27.5	2,150	--	--	3	
6	Akkin	27.5	4,000	6.9	930	3	Major ion and trace element sample
7	Aky	27	2,700	--	--	2	
8	Aitel	27	2,100	--	--	<1	
9	Matou	27	1,350	--	--	--	
10	Sobi	27	600	--	--	2	
Taro patch 1		26.5	2,100	--	--	--	
Taro patch 2		29	420	--	--	--	
			540	--	--	--	
			390	--	--	--	
			660	--	--	--	
Taro patch 3		27	740	--	--	--	
Taro patch 4		29.5	>8,000	--	--	--	



**Figure 22.** Well locations, specific conductance, and nitrate concentrations for Fananu Island, Nomwin Atoll, Hall Island Group, Chuuk State, 1984.

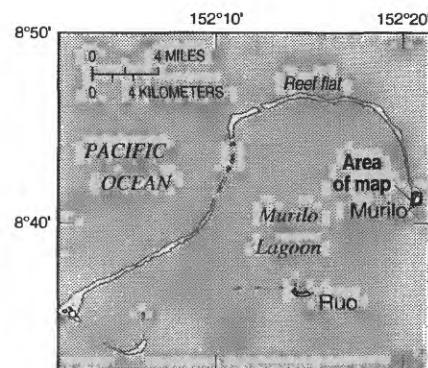
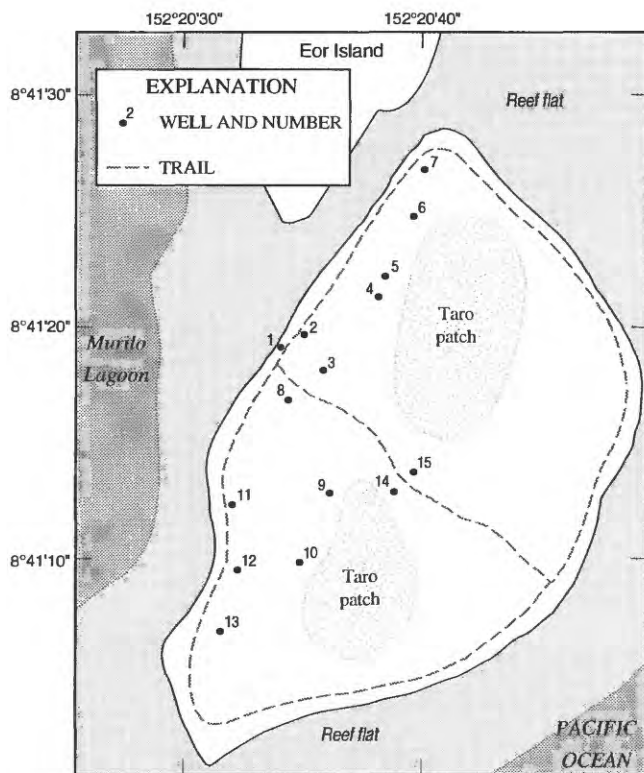
## Murilo Island

The population of Murilo Island at Murilo Atoll is about 330 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Murilo Island are shown in figure 23. Selected physical and water-quality data for the 15 dug wells sampled are given in table 15. The mean specific conductance for water from 15 wells was 1,120  $\mu\text{S}/\text{cm}$

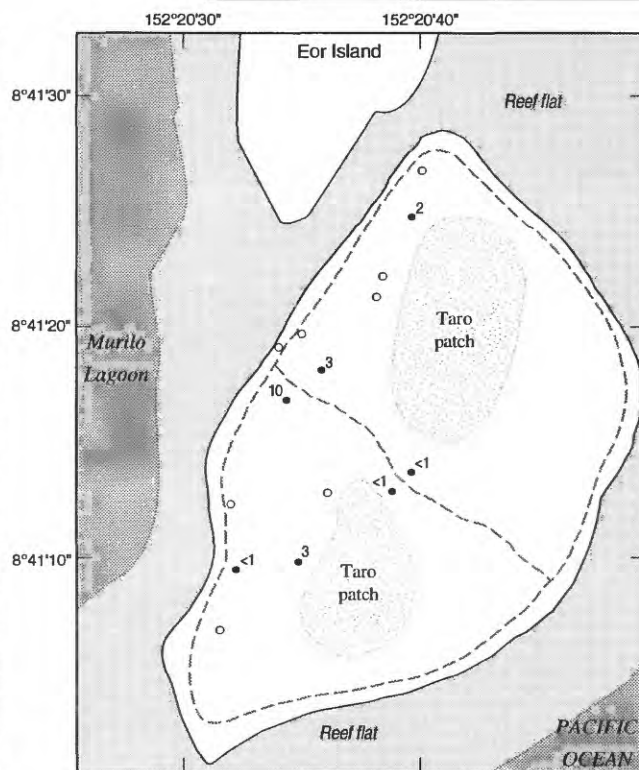
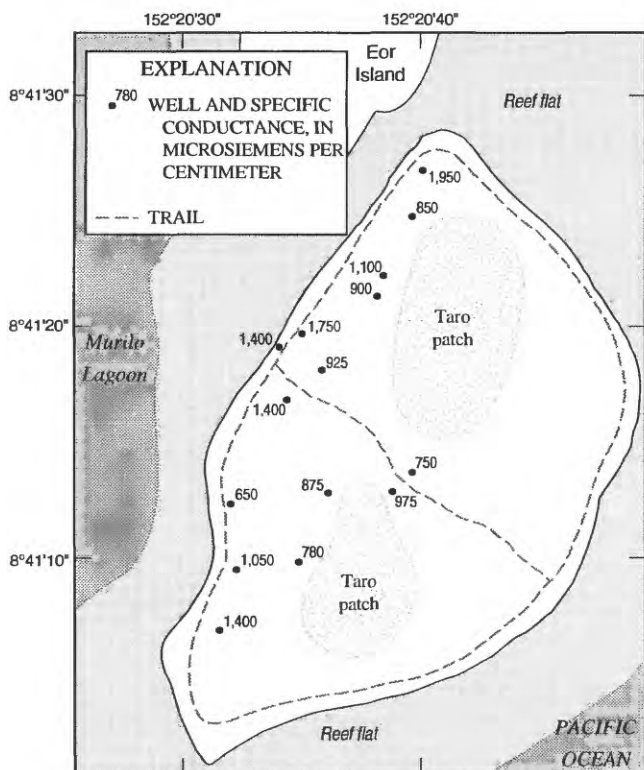
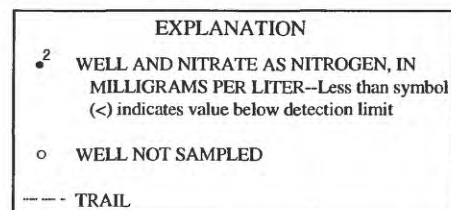
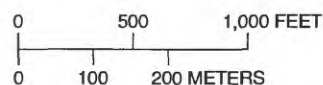
and ranged from 650 to 1,950  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from 2 of the 15 wells sampled (wells 2 and 7) exceeded the WHO (1984) guideline for chloride. Seven of the 10 wells sampled were field tested for nitrate concentration. Water from 3 of 7 the wells tested had nitrate concentrations of less than 1 mg/L (as N); the others had concentrations ranging from 2 to 10 mg/L (as N).

**Table 15.** Selected physical and water-quality data from dug wells, March 4, 1984, Murilo Island, Murilo Atoll, Hall Island Group [°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Itet	27.0	1,400	6.9	220	--	
2	Micky	26.5	1,750	6.9	--	--	
3	Rotcnis	26.5	925	7.0	--	3	
4	Kawa	26.5	900	6.9	75	--	
5	Benjamin	26.5	1,100	6.9	--	--	
6	Marcos	26.5	850	7.0	--	2	
7	Jonas	27	1,950	--	340	--	
8	Ellas	27	1,400	6.6	--	10	
9	Dennis	27	875	6.8	--	--	
10	Thomas	27	780	7.2	--	3	
11	Amita	27	650	7.2	--	--	
12	Tereky	27	1,050	6.9	--	<1	
13	Take	26.5	1,400	7.3	--	--	
14	Near	27	975	7.1	--	<1	Major ion and trace element sample
15	Aunu	27	750	7.1	--	<1	



**MURILO ATOLL**



**Figure 23.** Well locations, specific conductance and nitrate concentrations for Murilo Island, Murilo Atoll, Hall Island Group, Chuuk State, 1984.

## Ruo Island

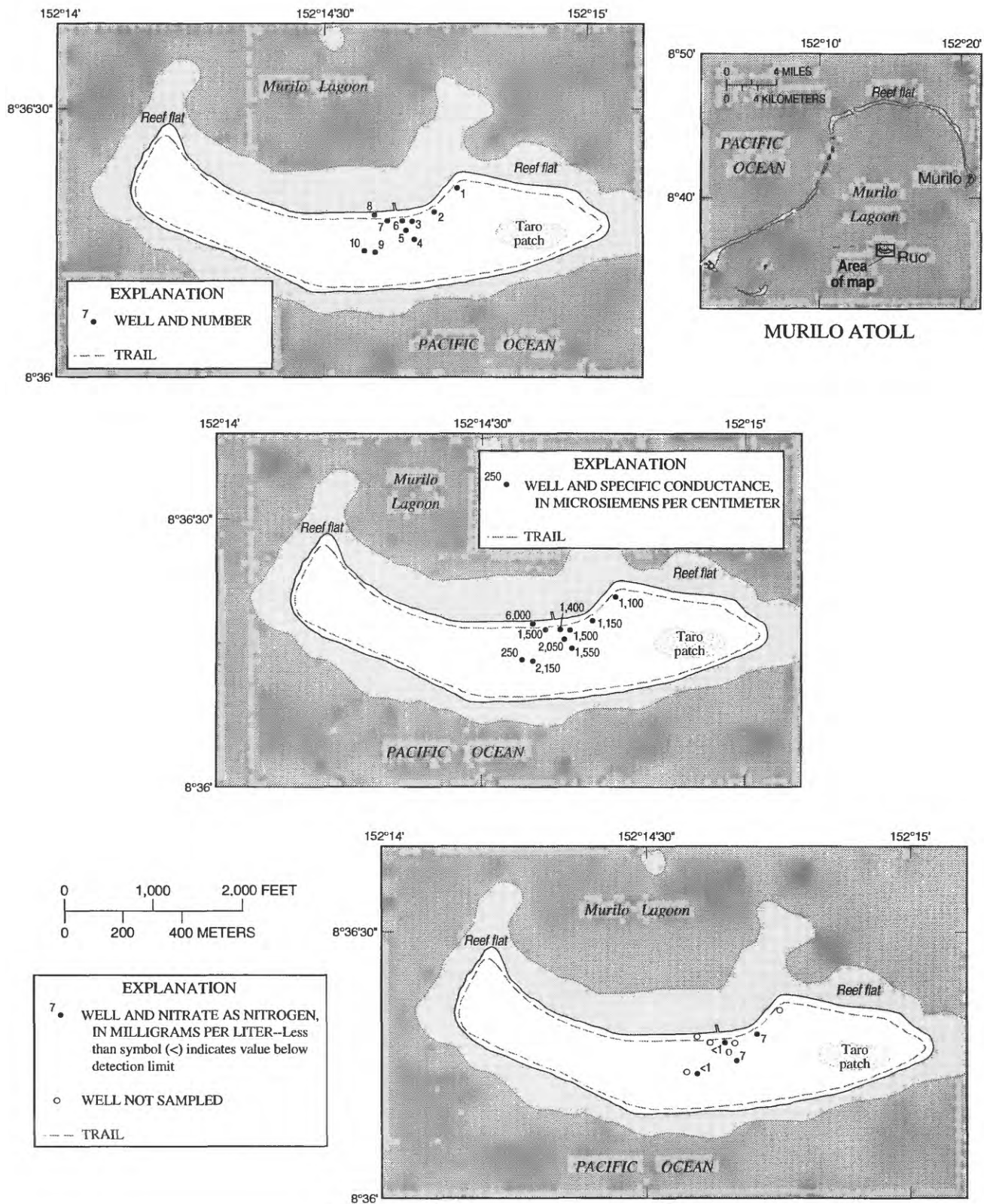
The population of Ruo Island at Murilo Atoll is about 298 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Ruo Island are shown in figure 24. Selected physical and water-quality data for the 10 dug wells sampled are given in table 16. The mean specific conductance for water from 10 wells was 1,860  $\mu\text{S}/\text{cm}$

and ranged from 250 to 6,000  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from 4 of the 10 wells sampled (wells 4, 5, 8, and 9) exceeded the WHO (1984) guideline for chloride. Four of the 10 wells sampled were field tested for nitrate concentration. Water from 2 of the 4 wells tested had nitrate concentrations of less than 1 mg/L (as N); the others had concentrations of 2 and 7 mg/L (as N).

**Table 16.** Selected physical and water-quality data from dug wells, March 4, 1984, Ruo Island, Murilo Atoll, Hall Island Group [°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ as N (mg/L)	Remarks
1	Koichi	27.5	1,100	7.4	--	--	
2	Tito	27.5	1,150	--	--	7	
3	Ritok	27.5	1,500	--	--	--	
4	Pio	27	1,550	6.7	180	7	Major ion and trace element sample
5	Koichi	27.5	2,050	--	--	--	
6	Erman	28	1,400	--	--	<1	
7	Ichiro	27	1,500	--	--	--	
8	David	28.5	6,000	--	--	--	
9	Nafer	27	2,150	--	--	<1	
10	Yoichi	27	250	--	--	--	





**Figure 24.** Well locations, specific conductance, and nitrate concentrations for Ruo Island, Murilo Atoll, Hall Island Group, Chuuk State, 1984.

## Mortlock Island Group

The inhabited islands of the Mortlock Island Group are Nema Island, Losap and Piis-Emwar Islands at Losap Atoll, Namoluk Island at Namoluk Atoll, Ettal Island at Ettal Atoll, Lukunoch and Oneop Islands at Lukunoch Atoll, and Satowan, Ta, Kuttu, and Moch Islands at Satowan Atoll (fig. 25). These islands are between 50 and 200 mi southwest of the Chuuk Island Group. Mean values for specific conductance of ground

water on each of the islands ranged between 660  $\mu\text{S}/\text{cm}$  on Namoluk Island to 2,650  $\mu\text{S}/\text{cm}$  on Nema Island. Field determinations for nitrate concentration of ground water ranged from less than 1 mg/L (as N) at selected sites on all islands to 14 mg/L (as N) on Kuttu Island. Table 17 includes physical, major-ion, and trace-element data for selected wells in the Mortlock Island Group. Specific information for each of the islands is presented below.

**Table 17.** Physical, major ion, and trace element data for selected wells in the Mortlock Island Group, Chuuk State  
[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25°C; mg/L, milligrams per liter;  $\mu\text{g}/\text{L}$ , micrograms per liter;  $\text{CaCO}_3$ , calcium-carbonate; --, not measured; <, less than]

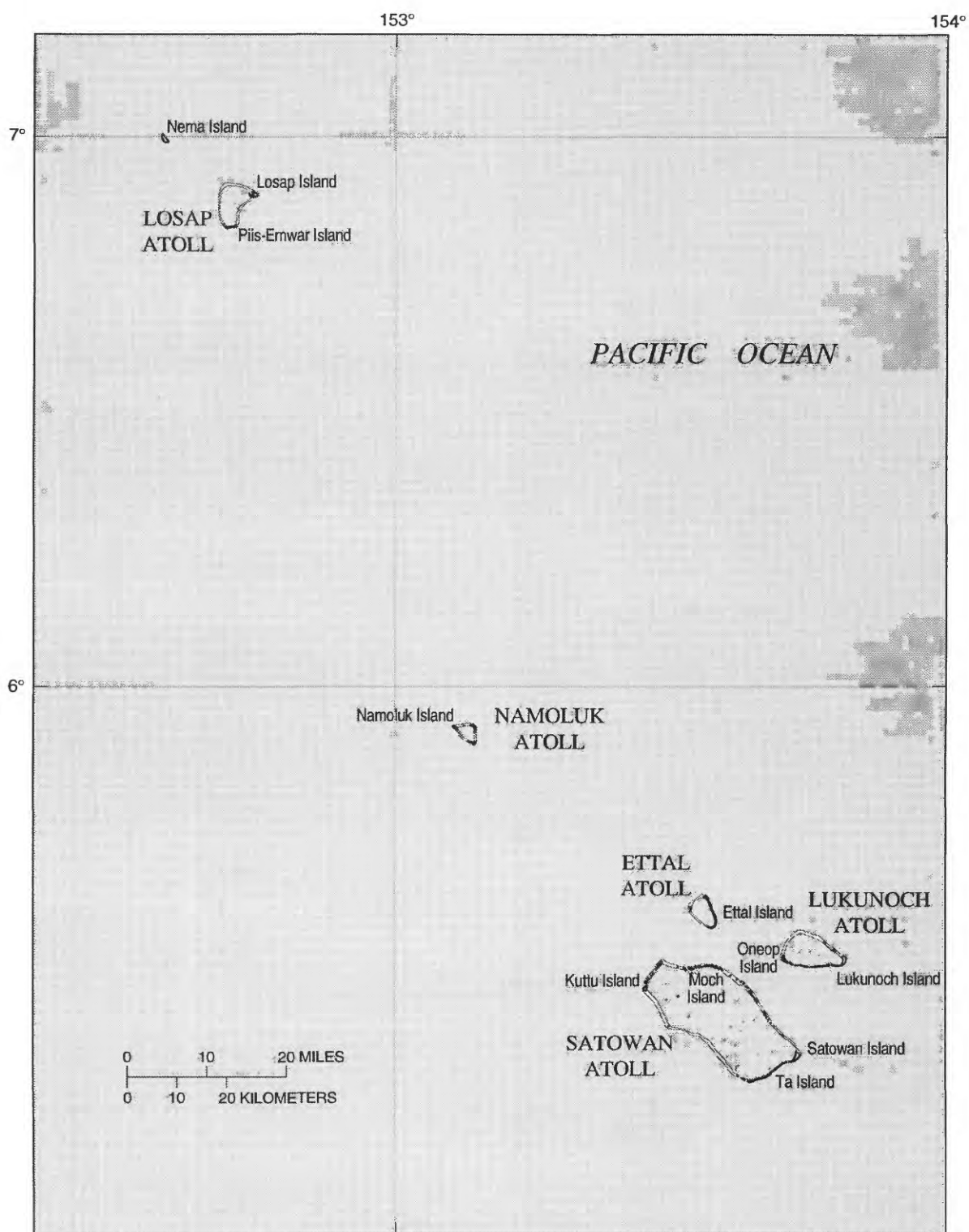
Property or constituent	Units	Nema well 3 03/03/85	Losap well 6 03/06/85	Piis-Emwar well 9 03/04/85
Specific conductance	$\mu\text{S}/\text{cm}$	8,000	1,090	630
pH	units	7.3	7.1	7.1
Temperature	°C	27.0	27.0	27.0
Hardness as $\text{CaCO}_3$	mg/L	--	--	--
Calcium, total as Ca	mg/L	180	130	96
Magnesium, total as Mg	mg/L	160	20	--
Sodium, total as Na	mg/L	1,300	67	16
Potassium, total as K	mg/L	48	18	15
Alkalinity, total as $\text{CaCO}_3$	mg/L	304	396	257
Sulfate, dissolved as $\text{SO}_4$	mg/L	330	36	12
Chloride, dissolved as Cl	mg/L	2,300	83	19
Fluoride, total as F	mg/L	0.4	0.3	0.2
Silica, dissolved as $\text{SiO}_2$	mg/L	1.8	6.3	3.2
Dissolved solids, calculated, sum of constituents	mg/L	4,510	628	351
Aluminum, total as Al	mg/L	200	50	90
Arsenic, total as As	$\mu\text{g}/\text{L}$	<1	2	<1
Barium, total as Ba	$\mu\text{g}/\text{L}$	200	200	200
Beryllium, total as Be	$\mu\text{g}/\text{L}$	<10	<10	<10
Cadmium, total as Cd	$\mu\text{g}/\text{L}$	2	<1	<1
Chromium, total as Cr	$\mu\text{g}/\text{L}$	20	20	10
Cobalt, total as Co	$\mu\text{g}/\text{L}$	<1	<1	1
Copper, total as Cu	$\mu\text{g}/\text{L}$	2	7	6
Iron, total as Fe	$\mu\text{g}/\text{L}$	690	110	190
Iron, dissolved as Fe	$\mu\text{g}/\text{L}$	70	70	35
Lead, total as Pb	$\mu\text{g}/\text{L}$	<1	<1	<1
Lithium, total as Li	$\mu\text{g}/\text{L}$	290	110	80
Manganese, total as Mn	$\mu\text{g}/\text{L}$	30	20	60
Manganese, dissolved as Mn	$\mu\text{g}/\text{L}$	20	1	8.2
Mercury, total as Hg	$\mu\text{g}/\text{L}$	--	--	--
Molybdenum, total as Mo	$\mu\text{g}/\text{L}$	1	1	<1
Nickel, total as Ni	$\mu\text{g}/\text{L}$	7	6	4
Selenium, total as Se	$\mu\text{g}/\text{L}$	<1	<1	<1
Silver, total as Ag	$\mu\text{g}/\text{L}$	<1	<1	<1
Zinc, total as Zn	$\mu\text{g}/\text{L}$	20	30	20

**Table 17.** Physical, major ion, and trace element data for selected wells in the Mortlock Island Group, Chuuk State  
--Continued

Property or constituent	Units	Namoluk well 28 02/21/84	Ettal well 20 02/19/84	Lukunoch well 35 10/25/85	Oneop well 15 10/24/85
Specific conductance.....	µS/cm	600	650	900	670
pH .....	units	7.1	7.1	7.0	6.9
Temperature .....	°C	28.5	26.5	27.5	29.5
Hardness as CaCO <sub>3</sub> .....	mg/L	310	310	370	350
Calcium, total as Ca .....	mg/L	110	96	120	--
Magnesium, total as Mg .....	mg/L	8.6	16	17	11
Sodium, total as Na .....	mg/L	11	17	47	16
Potassium, total as K .....	mg/L	1.7	2.9	6.4	1.1
Alkalinity, total as CaCO <sub>3</sub> .....	mg/L	300	310	325	326
Sulfate, dissolved as SO <sub>4</sub> .....	mg/L	7.9	11	25	--
Chloride, dissolved as Cl .....	mg/L	8.3	20	73	23
Fluoride, total as F .....	mg/L	0.3	1.6	0.3	0.7
Silica, dissolved as SO <sub>2</sub> .....	mg/L	3.7	1.2	3.9	2
Dissolved solids, calculated, sum of constituents .....	mg/L	344	360	489	385
Aluminum, total as Al .....	mg/L	20	20	<10	<10
Arsenic, total as As .....	µg/L	43	<1	1	<1
Barium, total as Ba .....	µg/L	<100	<100	<100	<100
Beryllium, total as Be .....	µg/L	<10	<10	<10	<10
Cadmium, total as Cd .....	µg/L	5	--	<1	<1
Chromium, total as Cr .....	µg/L	10	<10	<10	<10
Cobalt, total as Co .....	µg/L	<1	<1	<1	<1
Copper, total as Cu .....	µg/L	6	6	1	5
Iron, total as Fe .....	µg/L	50	180	190	<10
Iron, dissolved as Fe .....	µg/L	21	34	23	6
Lead, total as Pb .....	µg/L	4	4	3	--
Lithium, total as Li .....	µg/L	<10	<10	<10	<10
Manganese, total as Mn .....	µg/L	10	20	20	20
Manganese, dissolved as Mn .....	µg/L	10	--	10	11
Mercury, total as Hg .....	µg/L	<0.1	<0.1	--	--
Molybdenum, total as Mo .....	µg/L	1	1	<1	1
Nickel, total as Ni .....	µg/L	11	9	6	5
Selenium, total as Se .....	µg/L	<1	<1	<1	<1
Silver, total as Ag .....	µg/L	2	<1	1	<1
Zinc, total as Zn .....	µg/L	30	50	30	20

**Table 17.** Physical, major ion, and trace element data for selected wells in the Mortlock Island Group, Chuuk State  
--Continued

Property or constituent	Units	Satowan well 38 10/23/85	Ta well 18 10/27/85	Kuttu well 28 02/17/84	Moch well 18 02/18/84
Specific conductance. ....	µS/cm	--	860	750	800
pH .....	units	7.1	7.1	7.4	7.3
Temperature .....	°C	27.5	27.5	27.0	27.0
Hardness as CaCO <sub>3</sub> .....	mg/L	200	320	270	310
Calcium, total as Ca .....	mg/L	72	87	83	100
Magnesium, total as Mg .....	mg/L	5.8	24	15	15
Sodium, total as Na .....	mg/L	14	65	43	44
Potassium, total as K .....	mg/L	0.7	2.7	7.5	4
Alkalinity, total as CaCO <sub>3</sub> .....	mg/L	194	276	268	316
Sulfate, dissolved as SO <sub>4</sub> .....	mg/L	19	28	29	32
Chloride, dissolved as Cl .....	mg/L	11	100	45	43
Fluoride, total as F .....	mg/L	0.3	0.4	0.4	0.2
Silica, dissolved as SO <sub>2</sub> .....	mg/L	1.7	0.4	4.4	3.3
Dissolved solids, calculated, sum of constituents .....	mg/L	243	473	421	458
Aluminum, total as Al .....	mg/L	<10	10	30	20
Arsenic, total as As .....	µg/L	<1	<1	1	1
Barium, total as Ba .....	µg/L	<100	<100	<100	<100
Beryllium, total as Be .....	µg/L	<10	<10	<10	<10
Cadmium, total as Cd .....	µg/L	1	1	3	1
Chromium, total as Cr .....	µg/L	<10	<10	<10	<10
Cobalt, total as Co .....	µg/L	1	<1	<1	2
Copper, total as Cu .....	µg/L	--	13	3	5
Iron, total as Fe .....	µg/L	250	210	40	100
Iron, dissolved as Fe .....	µg/L	24	40	26	37
Lead, total as Pb .....	µg/L	3	7	3	3
Lithium, total as Li .....	µg/L	<10	<10	<10	<10
Manganese, total as Mn .....	µg/L	20	20	57	46
Manganese, dissolved as Mn .....	µg/L	9	9	57	46
Mercury, total as Hg .....	µg/L	--	--	0.1	<0.1
Molybdenum, total as Mo .....	µg/L	<1	<1	1	1
Nickel, total as Ni .....	µg/L	6	3	8	13
Selenium, total as Se .....	µg/L	<1	<1	<1	<1
Silver, total as Ag .....	µg/L	<1	<1	<1	<1
Zinc, total as Zn .....	µg/L	1,000	400	170	70



**Figure 25.** Mortlock Island Group, Chuuk State, Federated States of Micronesia.



## Nema Island

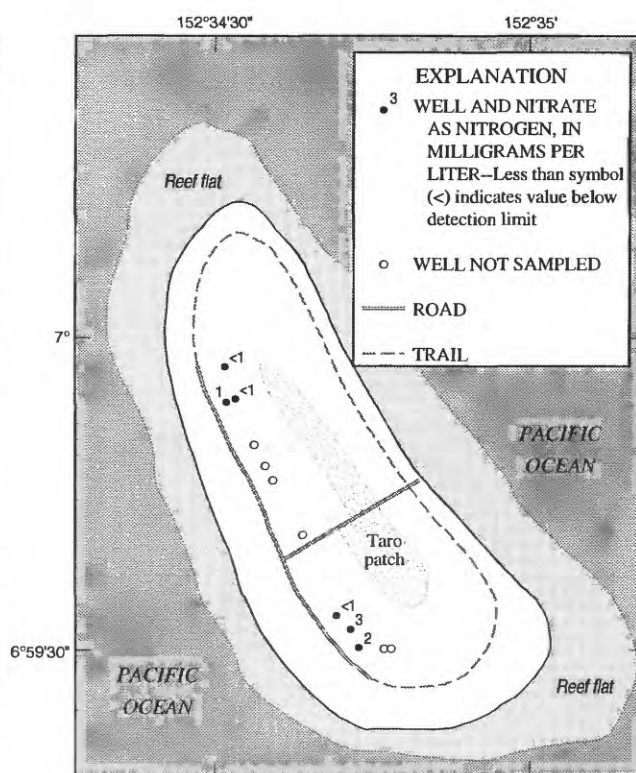
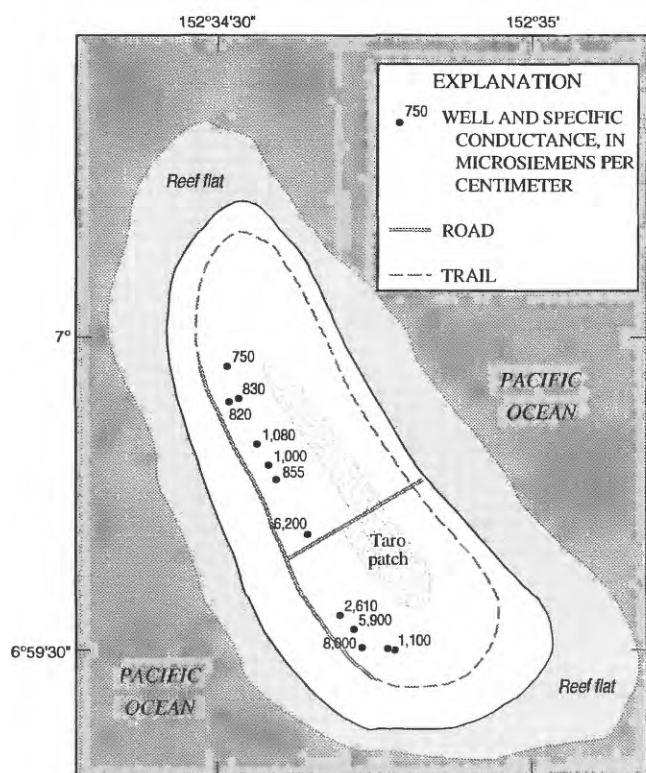
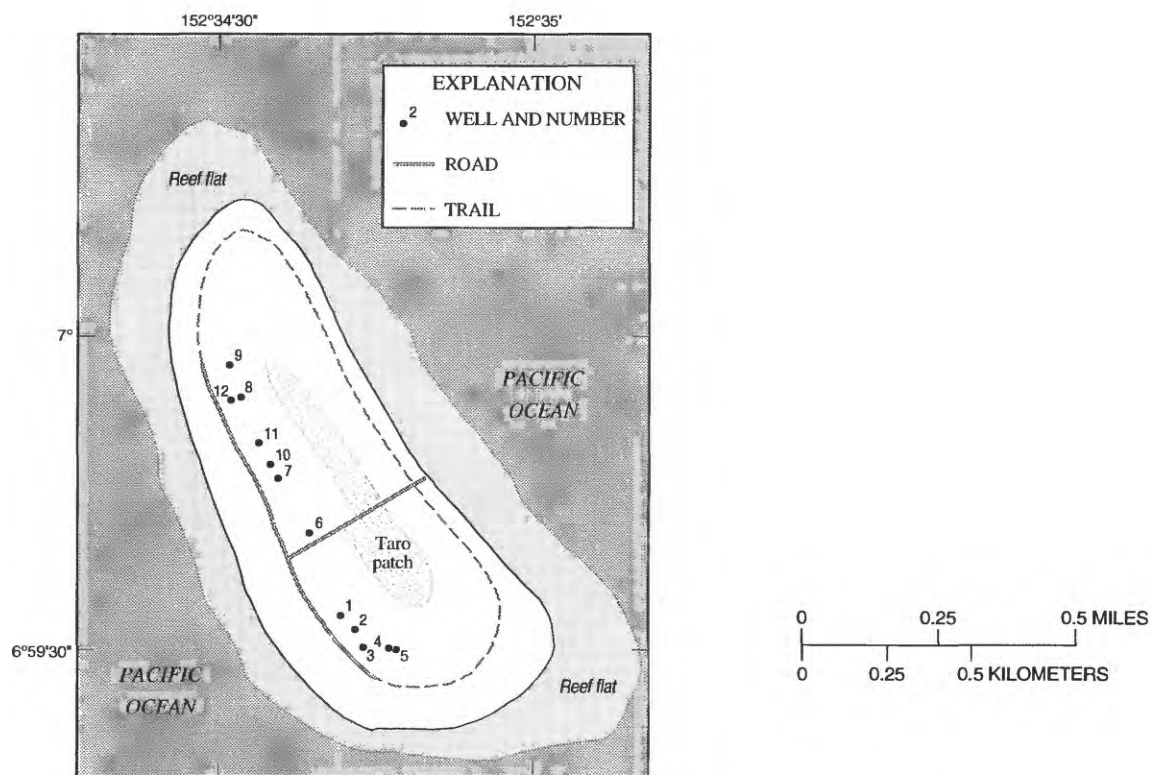
The population of Nema Island is about 1,021 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Nema Island are shown in figure 26. Selected physical and water-quality data for the 11 dug wells and 1 driven well sampled are given in table 18. The mean specific conductance for water from 12 wells

was 2,650  $\mu\text{S}/\text{cm}$  and ranged from 750 to 8,000  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from 4 of 12 wells (wells 1, 2, 3, and 6) exceeded the WHO (1984) guideline for chloride. Six of the 12 wells sampled were field tested for nitrate concentration. Water from half of the wells tested had nitrate concentrations of less than 1 mg/L (as N); the remaining samples had concentrations ranging from 1 to 3 mg/L (as N).

**Table 18.** Selected physical and water-quality data from dug and driven wells, March 3, 4, and 7, 1984, Nema Island, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Raeol	27	2,610	--	--	<1	
2	Efta	27	5,900	--	1,700	3	
3	Kerad	27	8,000	7.3	2,300	2	Major trace element sample
4	Kirsina	--	--	--	--	--	
5	Kirsina	26.5	1,100	--	--	--	
6	Asika	--	--	--	--	--	
6	Asika	26.5	6,200	--	--	--	
7	Manil	26	855	--	--	--	
8	Ngas	26.5	830	--	--	<1	
9	Martin	26.5	750	--	21	<1	
10	Tomo	26	1,000	--	--	--	
11	Luthur	26	1,080	--	--	--	
12	Municipal	--	820	--	--	1	Installed 1 1/4" well point with hand pump



**Figure 26.** Well locations, specific conductance, and nitrate concentrations for Nema Island, Mortlock Island Group, Chuuk State, 1985.

## Losap Island

The population of Losap Island at Losap Atoll is about 587 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Losap Island are shown in figure 27. Selected physical and water-quality data for the 23 dug wells and 1 driven well sampled are given in table 19. The mean specific conductance for water from 24 wells was 1,260  $\mu\text{S}/\text{cm}$  and ranged from 620 to 3,700  $\mu\text{S}/\text{cm}$ .

On the basis of the estimated chloride concentrations from specific conductance data, water from 6 of the 24 wells sampled (wells 4, 5, 9, 11, 12, and 23) exceeded the WHO (1984) guideline for chloride. Twenty-two of the 24 wells sampled were field tested for nitrate concentration. Water from slightly more than half the wells tested had nitrate concentrations of less than 1 mg/L (as N); the remaining samples had concentrations ranging from 1 to 6 mg/L (as N).

**Table 19.** Selected physical and water-quality data from dug and driven wells, March 6, 1984, Losap Island, Losap Atoll, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Takis	27	910	--	--	<1	
2	Chipen	27	940	--	--	5	
3	Soiakim	27	620	--	--	<1	
4	Wesne	27	3,700	--	880	3	
5	Kiyoshi	27	1,650	--	220	<1	
6	Aukos	27	1,080	7.1	88	4	Major ion and trace element sample
7	Samuel	27	900	--	--	2	
8	Sasta	27	1,070	--	--	6	
9	Son	27.5	2,200	--	430	2	
10	Anton	26.5	1,300	--	--	1	
11	Eliab	27	1,600	--	--	<1	
12	Aidel	27	1,800	--	--	<1	
13	Ermis	26.5	850	--	--	--	
14	Teruo	26.5	1,000	--	--	<1	
15	Tolove	26.5	650	--	--	<1	
16	Ichio	27	850	--	--	<1	
17	Atarino	27	790	--	--	--	
18	Sachuo	27	730	--	--	<1	
19	Taini	26	980	--	--	<1	
20	Sincho	27	780	--	--	<1	
21	Mathew	27	850	--	--	<1	
22	Tupun	27	1,250	--	--	<1	
23	David	26.5	3,000	--	700	<1	
24	Municipal	27	680	--	--	<1	Installed 1 1/4" well point with hand pump



## Piis-Emwar Island

The population of Piis-Emwar Island at Losap Atoll is about 240 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Piis-Emwar Island are shown in figure 28. Selected physical and water-quality data for the 18 dug wells, 1 driven well, and 3 taro patch sites sampled are given in table 20. The mean specific conductance for water from 19 wells was 940  $\mu\text{S}/\text{cm}$  and ranged from 560 to 1,700  $\mu\text{S}/\text{cm}$ . The highest mea-

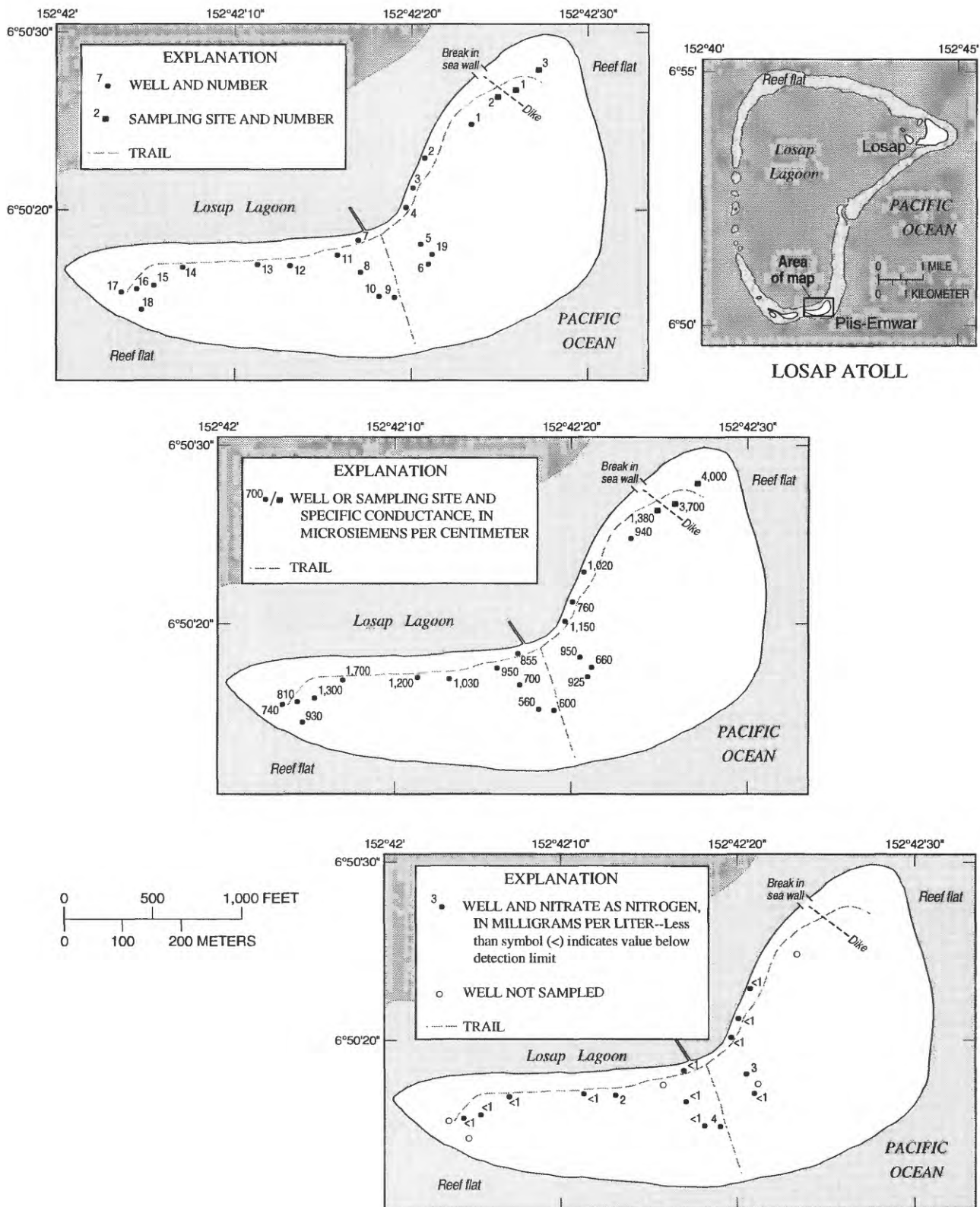
sured value of specific conductance (4,000  $\mu\text{S}/\text{cm}$ ) was for a water sample collected from a taro patch at the northeast end of the island. On the basis of the estimated chloride concentrations from specific conductance data, water from 1 of the 19 wells sampled (well 14) exceeded the WHO (1984) guideline for chloride. Fifteen of the 19 wells sampled were field tested for nitrate concentration. Water from 12 of the 15 wells tested had nitrate concentrations of less than 1 mg/L (as N); the others had concentrations ranging from 2 to 4 mg/L (as N).

**Table 20.** Selected physical and water-quality data from dug and driven wells, March 4–5, 1984, Piis-Emwar Island, Losap Atoll, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no. or sampling sites	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Kisino	27	940	--	--	--	
2	Willy	27	1,020	--	--	<1	
3	Onna	27.5	760	--	--	<1	
4	Tea	27	1,150	--	130	<1	
5	Mathew	27	950	--	--	3	
6	Sichiro	26.5	925	7.1	--	<1	
7	Reit	28	855	--	92	<1	
8	Sachio	26.5	700	--	--	<1	
9	Kiomasa	27	630	--	19	4	Major ion and trace element sample
10	Herpis	27.5	560	--	--	<1	
11	Suta	26.5	950	--	--	<1	
12	Rosta	26	1,030	--	--	2	
13	Simauo	27	1,200	--	--	<1	
14	Tony	27	1,700	--	270	<1	
15	Robert	26.5	1,300	--	--	<1	
16	Ana	26	810	--	--	<1	
17	Satachy	26	740	--	--	--	
18	Pesa	26.5	930	--	--	--	
19	Municipal	27	660	--	39	--	Installed 1 1/4" well point with hand pump
Taro patch 1	Komet	27	3,700	--	--	--	
Taro patch 2		27	1,380	--	--	--	
Taro patch 3	Dochiy	27.5	4,000	--	--	--	





**Figure 28.** Well locations, specific conductance, and nitrate concentrations for Piis-Emwar Island, Losap Atoll, Mortlock Island Group, Chuuk State, 1985.

## Namoluk Island

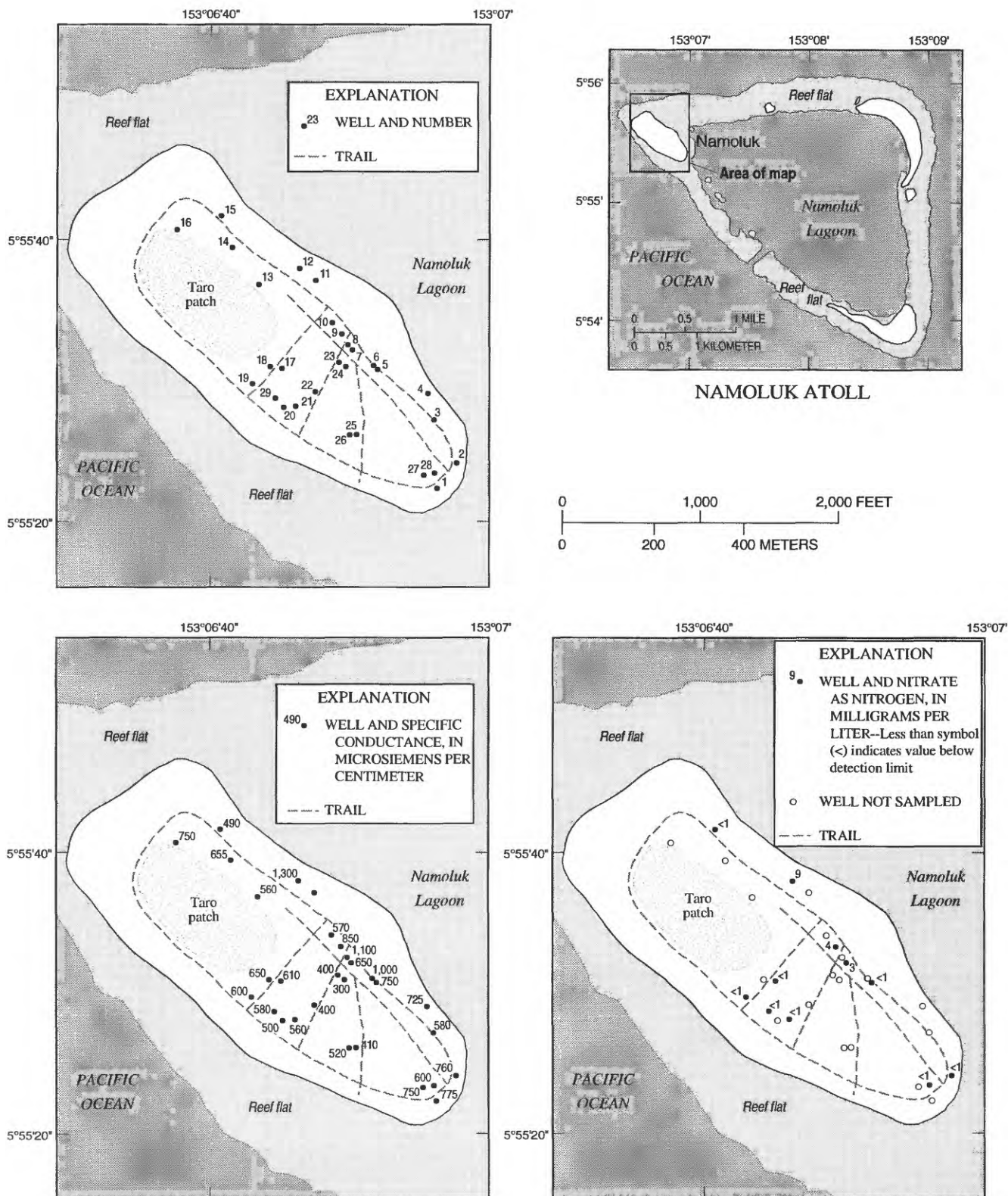
The population of Namoluk Island at Namoluk Atoll is about 329 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Namoluk Island are shown in figure 29. Selected physical and water-quality data for the 28 dug wells and 1 driven well sampled are given in table 21. The mean specific conductance for

water from 29 wells was 660  $\mu\text{S}/\text{cm}$  and ranged from 300 to 1,300  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, none of the water samples exceeded the WHO (1984) guideline for chloride. Eleven of the 29 wells sampled were field tested for nitrate concentration. Water from 9 of the 11 wells tested had nitrate concentrations of less than 1 mg/L (as N); the remaining samples had concentrations ranging from 3 to 9 mg/L (as N).

**Table 21.** Selected physical and water-quality data from dug and driven wells, February 21, 1984, Namoluk Island, Namoluk Atoll, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Luo	27.5	775	6.9	--	--	
2	Luo	26.5	760	7.1	--	<1	
3	Lak	27	580	7.2	--	--	
4	Letep	27	725	7.0	--	--	
5	Falukupat	27	750	6.8	--	<1	
6	Falukupat	27	1,000	7.1	90	--	
7	Somas	26.5	650	7.3	--	3	
8	Urua	26.5	1,100	7.2	--	--	
9	Yustin	27	850	7.1	--	4	
10	Kider	26.5	570	7.3	--	--	
11	Riper	--	--	--	--	--	
12	Riper	27	1,300	7.3	210	9	
13	School	27	560	7.1	--	--	
14	Misael	27	655	7.3	--	--	
15	Minne	27	490	7.3	28	<1	
16	Riochy	27	750	6.9	--	--	
17	Kintro	26.5	610	7.1	--	<1	
18	Dionis	27	650	7.1	--	--	
19	Sachuo	26.5	600	7.2	--	<1	
20	Kasio	27	500	7.2	--	--	
21	Seichy	27	560	7.1	--	<1	
22	Jacob	27	400	7.2	--	--	
23	Resty	26.5	400	7.2	--	--	
24	Benigno	26.5	300	7.3	--	--	
25	Isiel	27	410	7.4	--	--	
26	Nover	27	520	7.3	--	--	
27	Kilota	27	750	7.1	--	--	
28	Simon	28.5	600	7.1	8	<1	Major ion and trace element sample
29	Kasio	28	580	7.0	20	<1	Installed 1 1/4" well point with hand pump



**Figure 29.** Well locations, specific conductance, and nitrate concentrations for Namoluk Island, Namoluk Atoll, Mortlock Island Group, Chuuk State, 1984.

## Ettal Island

The population of Ettal Island at Ettal Atoll is about 440 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Ettal Island are shown in figure 30. Selected physical and water-quality data for the 38 dug wells sampled are given in table 22. The mean specific conductance for water from 38 wells was 750  $\mu\text{S}/\text{cm}$

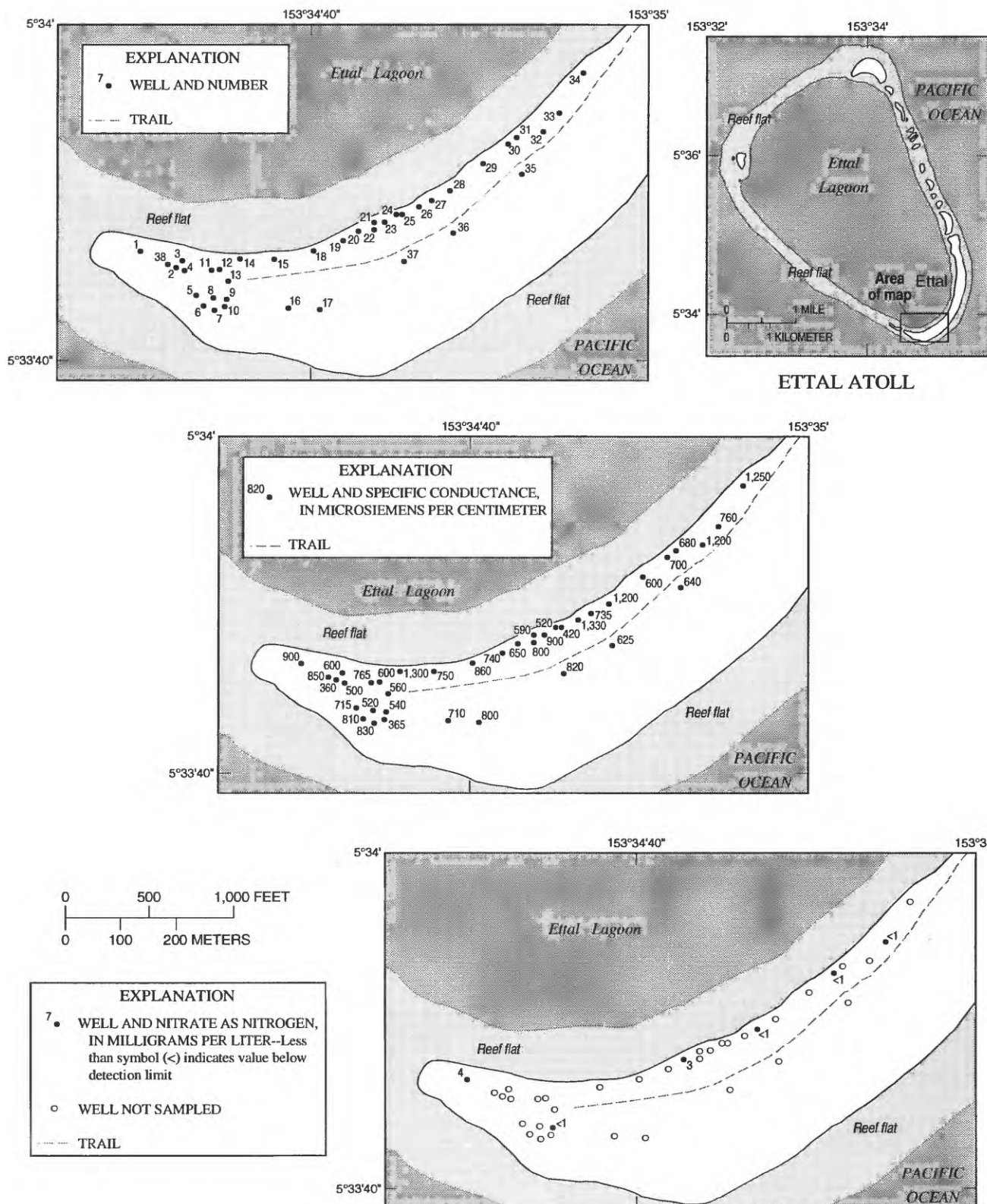
and ranged from 360 to 1,330  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, none of the water samples exceeded the WHO (1984) guideline for chloride. Six of the 38 wells sampled were field tested for nitrate concentration.

Water from 4 of the 6 wells tested had nitrate concentrations of less than 1 mg/L (as N); the remaining samples had concentrations of 3 and 4 mg/L (as N).

**Table 22.** Selected physical and water-quality data from dug wells, February 19, 1984, Ettal Island, Ettal Atoll, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Chief Choram	27.5	900	6.9	--	4	
2	Bernard	26.5	360	7.4	13	--	
3	Freadir	26.5	600	7.2	--	--	
4	Robert	26.5	500	7.3	--	--	
5	Kainer	27	715	6.9	--	--	
6	Ichiro	27	810	7.3	--	--	
7	Idil	27	830	7.2	--	--	
8	Kainer	27	520	7.1	--	--	
9	Toko	26.5	540	7.1	--	<1	
10	Edie	26.5	365	7.1	--	--	
11	Siten	26.5	765	7.2	--	--	
12	Nigasio	26.5	600	7.3	--	--	
13	Stepin	26.5	560	7.2	--	--	
14	Emilio	26.5	1,300	7.2	200	--	
15	Joe	26.5	750	7.3	--	--	
16	Moto	27	710	7.1	--	--	
17	Edie	26.5	800	7.1	--	--	
18	Istina	27	860	7.2	--	--	
19	Tobias	26.5	740	7.2	--	--	
20	Neme	26.5	650	7.1	20	3	Major ion and trace element sample
21	Nigasio	26.5	500	7.3	--	--	
22	Joseph	27	800	7.1	--	--	
23	Bat	27	900	7.1	--	--	
24	Chiako	27	520	7.3	--	--	
25	John	27	420	7.6	--	--	
26	Rito	26.5	1,330	7.2	--	--	
27	Rito	26.5	735	7.1	--	<1	
28	Peter	26.5	1,200	7.2	--	--	
29	Joseph	26.5	600	7.3	--	--	
30	Simel	29	700	7.3	--	<1	
31	Simel	27	680	7.2	--	--	
32	Alaster	26.5	1,200	7.3	--	--	
33	Hunter	26.5	760	7.2	--	<1	
34	Frank	27.5	1,250	7.1	--	--	
35	Joseph	27.5	640	7.4	--	--	
36	Tempa	26.5	625	7.5	--	--	
37	Lion	27	820	7.0	--	--	
38	Pest	28	850	--	--	--	



**Figure 30.** Well locations, specific conductance, and nitrate concentrations for Ettal Island, Ettal Atoll, Mortlock Island Group, Chuuk State, 1984.



## Lukunoch Island

The population of Lukunoch Island at Lukunoch Atoll is about 668 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Lukunoch Island are shown in figure 31. Selected physical and water-quality data for the 56 dug wells sampled are given in table 23. The mean specific conductance for water from 56 wells

was 830  $\mu\text{S}/\text{cm}$  and ranged from 400 to 2,600  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, 1 of the 56 wells sampled (well 9) exceeded the WHO (1984) guideline for chloride. Thirty-three of the 56 wells sampled were field tested for nitrate concentration. Water from all of the wells tested had nitrate concentrations of less than 1 mg/L (as N), except one, which had a concentration of 4 mg/L (as N).

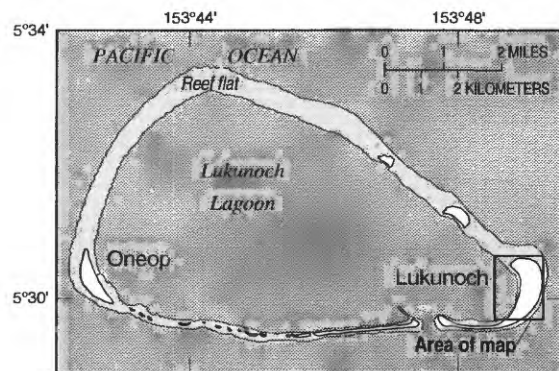
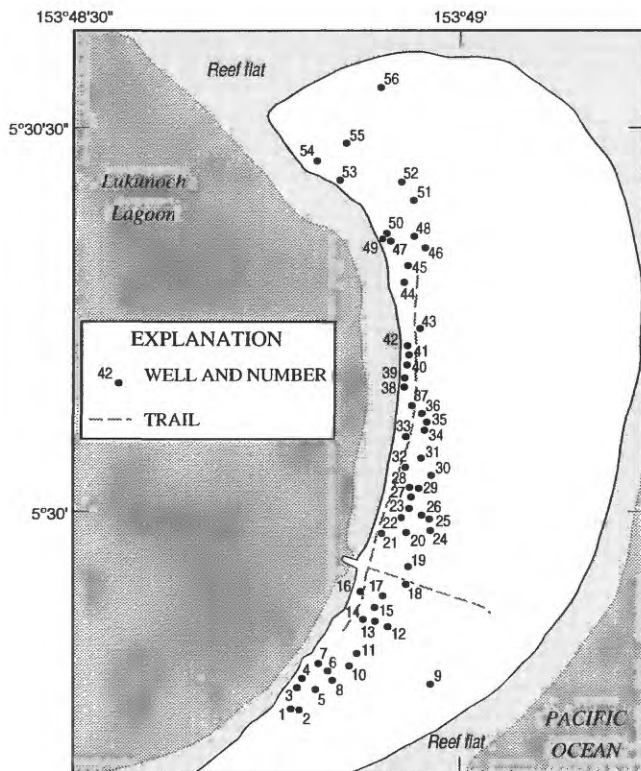
**Table 23.** Selected physical and water-quality data from dug wells, October 25, 1984, Lukunoch Island, Lukunoch Atoll, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; —, not measured; <, less than]

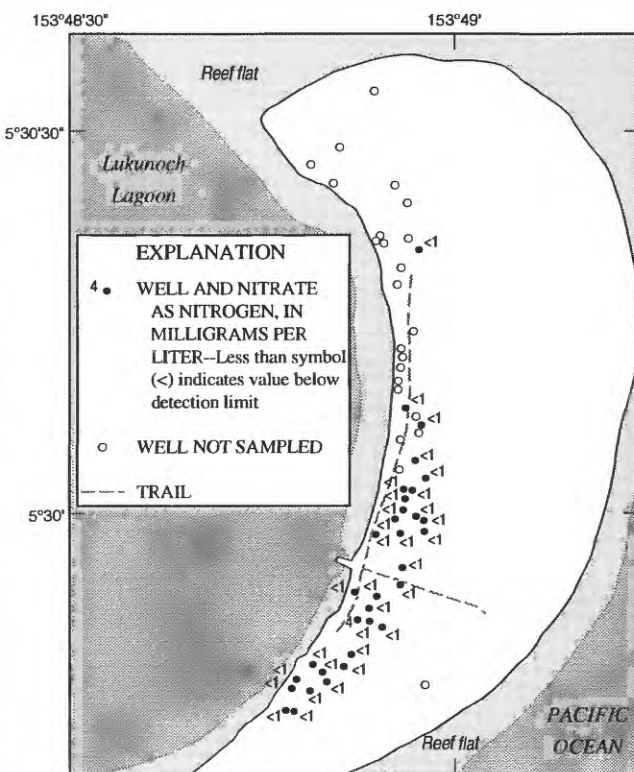
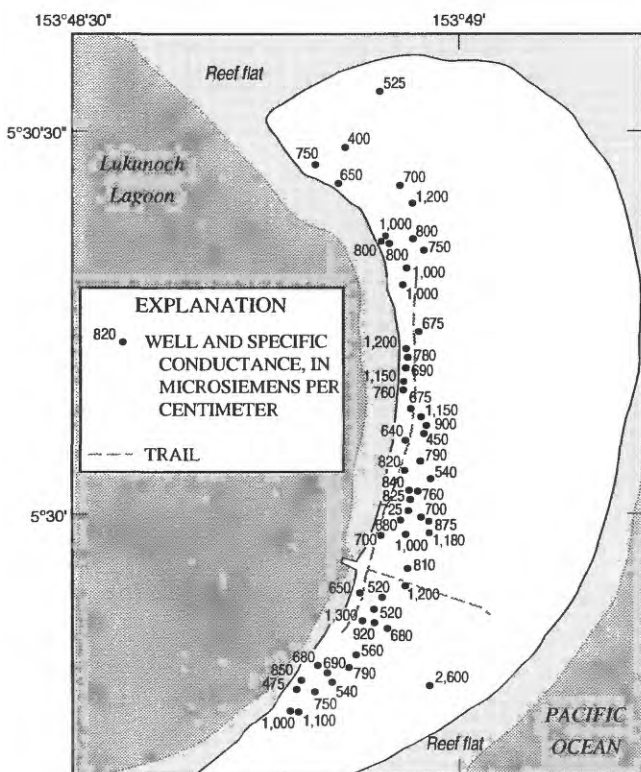
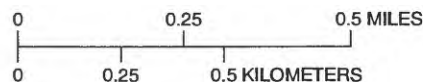
Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Mwarluk	27	1,000	--	--	<1	
2	Linn	28	1,100	--	--	<1	
3	Puas	28	475	--	--	<1	
4	Murito	27	850	--	--	<1	
5	Tasi	28	750	--	--	<1	
6	Mispi	29	690	--	--	<1	
7	Rayphano	28	680	--	--	<1	
8	Robert	28	540	--	--	<1	
9	not known	--	2,600	--	--	--	
10	Hainrick	28.5	790	--	--	<1	
11	Sitro	28	560	--	--	<1	
12	Puas	29.5	680	--	18	<1	
13	Rafael	29	920	--	--	<1	
14	Robert	29.5	1,300	--	--	4	
15	Sido	27	520	--	--	<1	
16	Nennis	28.5	650	--	--	<1	
17	Luke	28	520	--	--	<1	
18	Malia	27	1,200	--	--	<1	
19	Tefant	27	810	--	--	<1	
20	Fichipwe	26	1,000	--	--	<1	
21	Simon	28	700	--	--	<1	
22	Wenio	28	680	--	--	<1	
23	Elgin	27	725	--	--	<1	
24	Elginbwi	29	1,180	--	--	<1	
25	Marluk	27.5	875	--	--	<1	
26	Sekarb	27	700	--	--	<1	
27	Ikelap	28	825	--	--	<1	
28	Samson	27.5	840	--	--	<1	
29	Rayphan	28	760	--	--	<1	
30	Malia	28	540	--	--	<1	
31	Samson	28	790	--	--	<1	

**Table 23.** Selected physical and water-quality data from dug wells, October 25, 1984, Lukunoch Island, Lukunoch Atoll, Mortlock Island Group--Continued

Well no.	Owner	Temperature (°C)	Specific conductance (μS/cm)	pH	Cl (mg/L)	NO <sub>3</sub> , as N (mg/L)	Remarks
32	Sekarb	29	820	--	--	--	
33	Setir	27	640	--	--	--	
34	Katril	27	450	--	--	--	
35	Elginpwi	27.5	900	7.0	73	<1	Major ion and trace element sample
36	Eparisto	27	1,150	--	--	--	
37	Rabuda	28	675	--	--	<1	
38	Kiyoshi	27	760	--	--	--	
39	Likichimus	27	1,150	--	--	--	
40	Pulaua	28	690	--	--	--	
41	Chol	28	780	--	--	--	
42	Wenio	28	1,200	--	--	--	
43	Isasio	27.5	675	--	--	--	
44	Kamilo	28	1,000	--	--	--	
45	Eseteb	27	1,000	--	73	--	
46	Likishe	27.5	750	--	--	<1	
47	Puas	28.5	800	--	--	--	
48	Puas	28	800	--	--	--	
49	Thomas	27	800	--	--	--	
50	Kosy	27.5	1,000	--	--	--	
51	Patricio	27	1,200	--	--	--	
52	Nick	28	700	--	--	--	
53	Apong	27	650	--	--	--	
54	Marluk	27	750	--	--	--	
55	Pilas	27.5	400	--	--	--	
56	Sebastian	27.5	525	--	--	--	



LUKUNOCH ATOLL



**Figure 31.** Well locations, specific conductance, and nitrate concentrations for Lukunoch Island, Lukunoch Atoll, Mortlock Island Group, Chuuk State, 1985.

## Satowan Island

The population of Satowan Island at Satowan Atoll is about 766 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Satowan Island are shown in figure 32. Selected physical and water-quality data for the 63 dug wells and 1 driven well sampled are given in table 24. The mean specific conductance for water from

64 wells was 710  $\mu\text{S}/\text{cm}$  and ranged from 210 to 1,700  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from one well (well 57) exceeded the WHO (1984) guideline for chloride. Thirty-eight of the 61 wells sampled were field tested for nitrate concentration. Water from 32 of the 38 wells tested had nitrate concentrations of less than 1 mg/L (as N); the remaining samples had concentrations ranging from 1 to 5.5 mg/L (as N).

**Table 24.** Selected physical and water-quality data from dug wells, October 22, 23, and 27, 1984, Satowan Island, Satowan Atoll, Mortlock Island Group

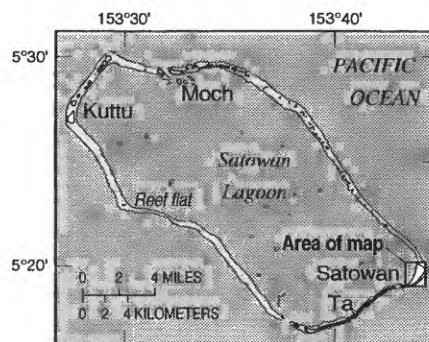
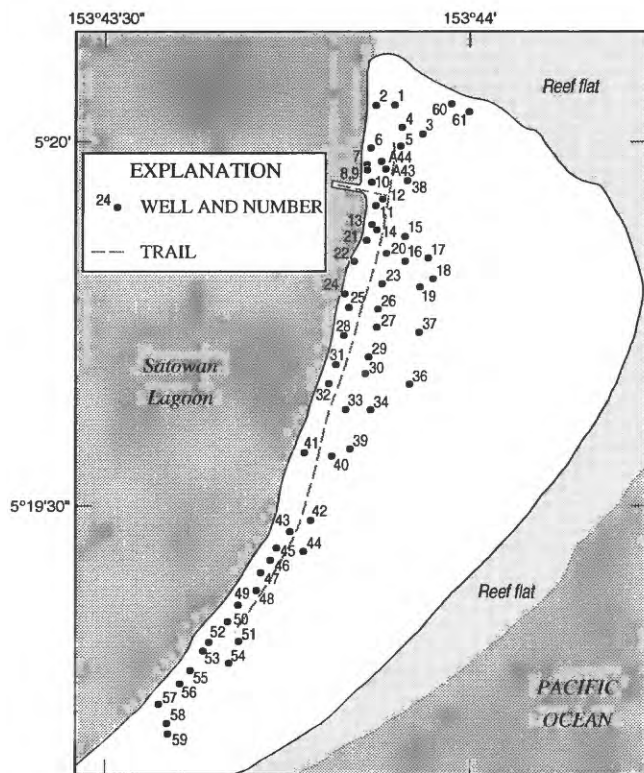
[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Ataao	27.5	720	--	--	<1	
2	Bernard	27	285	--	--	--	
3	School	28	950	--	--	--	
4	Pasiano	27.5	--	--	--	<1	
5	Ionas	27.5	565	--	--	<1	
6	John	28	820	--	--	--	
7	Roku	28	1,200	--	--	<1	
8	Kalis	27	710	--	--	5	
9	Marcus	28	1,200	--	--	5.5	
10	Kulian	28.5	750	--	--	<1	
11	Epifanio	28	500	--	--	<1	
12	Christian	26	210	--	--	<1	
13	Takao	28	700	--	--	<1	
14	Sarein	29	650	--	--	<1	
15	Roy	28	530	--	--	<1	
16	Aitel	27.5	850	--	--	<1	
17	Ichitaro	27	340	--	--	--	
18	Ain	29	320	--	--	<1	
19	Aisea	27.5	470	--	--	<1	
20	Sam	27	700	--	--	<1	
21	Topel	27.5	740	--	--	<1	
22	Bernard	28	535	--	--	<1	
23	Isamu	27.5	670	--	--	<1	
24	Masao	27	330	--	--	<1	
25	Simat	28.5	750	--	--	5.5	
26	Thomas	29.5	600	--	--	<1	
27	Elieisar	27.5	500	--	--	<1	
28	Akitaro	27	610	--	--	<1	
29	Kulian	26	310	--	--	<1	
30	Salvadore	28	640	--	--	<1	
31	Pelwin	29	560	--	--	<1	

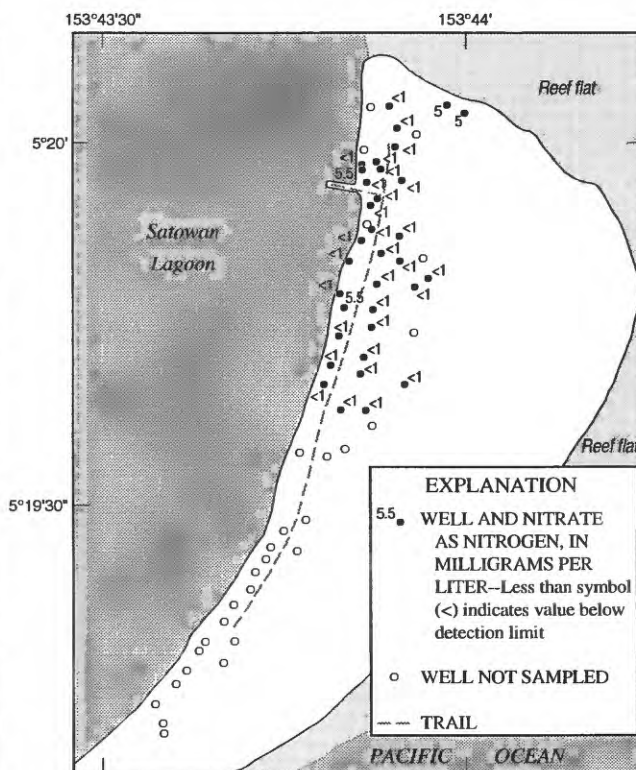
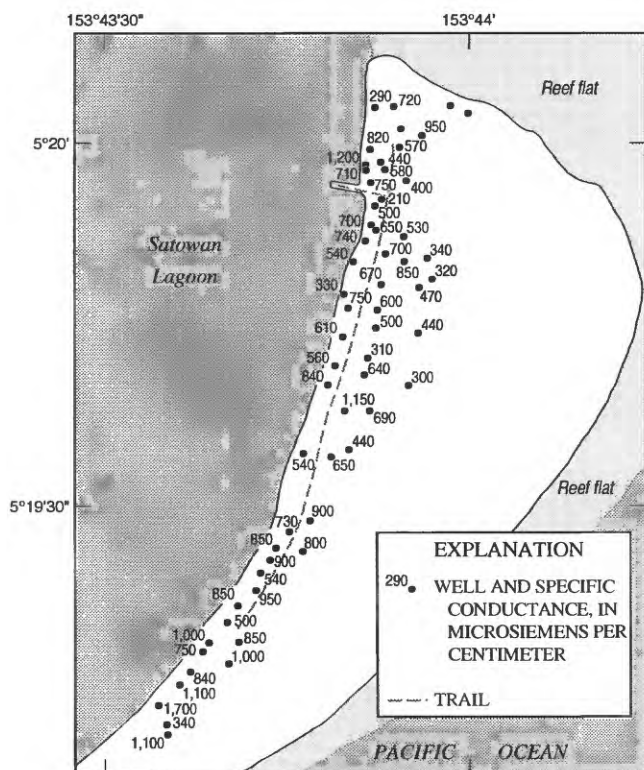
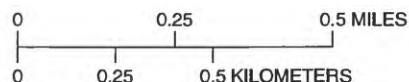
**Table 24.** Selected physical and water-quality data from dug wells, October 22, 23, and 27, 1984, Satowan Island, Satowan Atoll, Mortlock Island Group--Continued

Well no.	Owner	Temperature (°C)	Specific conductance (μS/cm)	pH	Cl (mg/L)	NO <sub>3</sub> , as N (mg/L)	Remarks
32	Titus	28	840	--	--	<1	
33	Siro	28	1,150	--	--	<1	
34	Raymond	28	690	--	--	<1	
35	Lewis	29.5	430	--	--	--	
36	Simeon	28	300	--	--	<1	
37	Tasiro	30	440	--	--	<1	
38	Misauo	27.5	395	7.1	11	1	Installed 1 1/4" well point with hand pump. Major ion and trace element sample
39	Santiago	28	440	--	--	--	
40	Sian	26.5	650	--	--	--	
41	Antonio	27	540	--	--	--	
42	Steven	28	900	--	--	--	
43	Thomas	26.5	725	--	--	--	
44	Tamian	28	800	--	--	--	
45	MataichiL	28	850	--	--	--	
46	Noel	27	900	--	--	--	
47	Kilian	27	540	--	--	--	
48	Akostian	28	950	--	--	--	
49	Haritos	27	850	--	--	--	
50	Florian	26	495	--	--	--	
51	Moufa	27	850	--	--	--	
52	Isau	27	1,000	--	--	--	
53	Filomen	27.5	950	--	--	--	
54	Penjamin	28.5	1,000	--	--	--	
55	Joseph	27	840	--	--	--	
56	Aleper	27	1,100	--	--	--	
57	Amon	27	1,700	--	--	--	
58	Simon	27	340	--	--	--	
59	Tas	27.5	1,100	--	--	--	
60	Girl's dorm	29	1,150	--	--	22	
61	Boy's dorm	27.5	695	--	--	22	
A1	Misauo	26.5	280	--	--	<1	
A43	Jack	27	580	--	--	<1	
A44	Kilaimer	26.5	438	--	--	<1	





SATOWAN ATOLL



**Figure 32.** Well locations, specific conductance, and nitrate concentrations for Satowan Island, Satowan Atoll, Mortlock Island Group, Chuuk State, 1985.

## Oneop Island

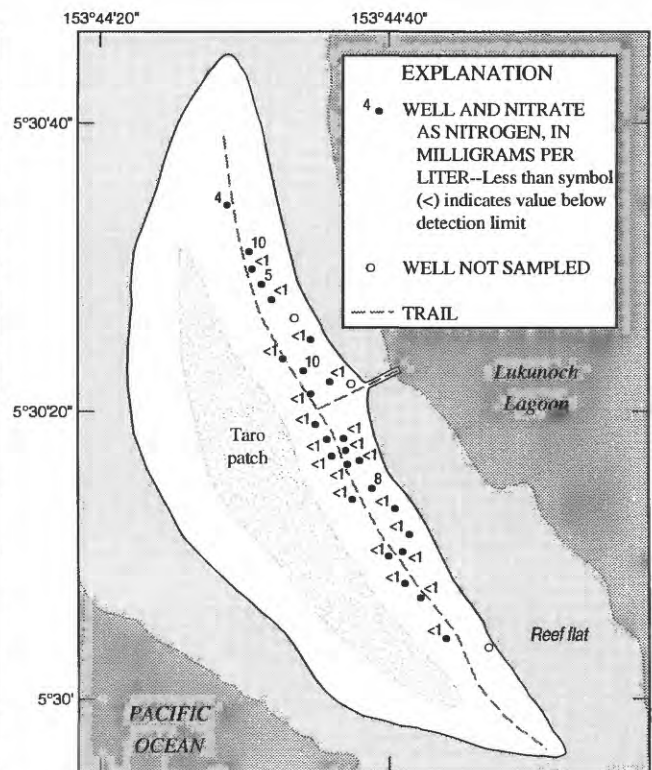
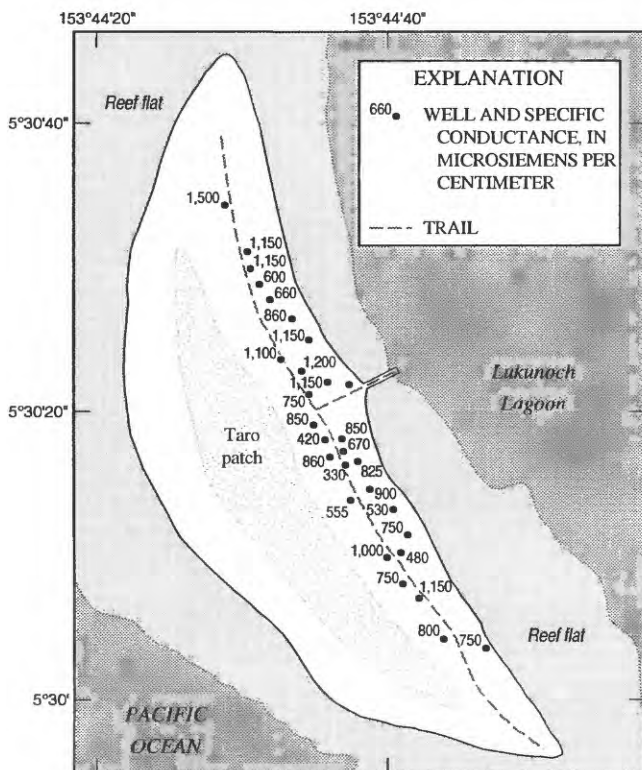
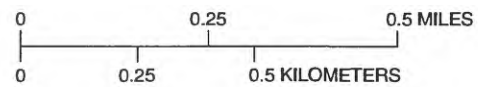
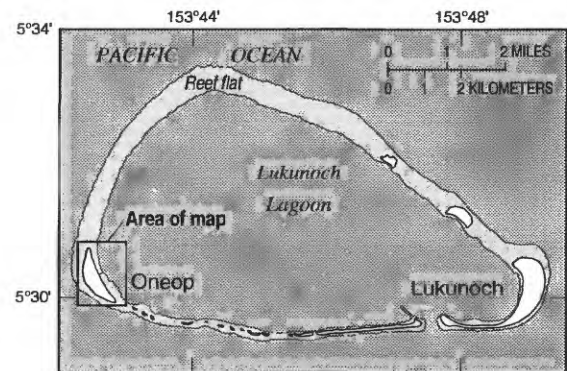
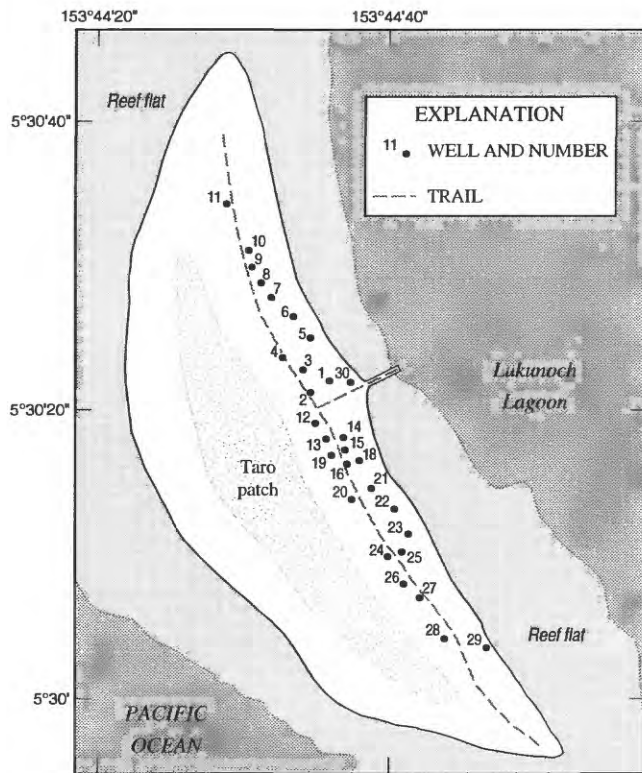
The population of Oneop Island at Lukunoch Atoll is about 485 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Oneop Island are shown in figure 33. Selected physical and water-quality data for the 29 dug wells and 1 driven well sampled are given in table 25. The mean specific conductance for water from

30 wells was 850  $\mu\text{S}/\text{cm}$  and ranged from 330 to 1,500  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, none of the water samples exceeded the WHO (1984) guideline for chloride. Twenty-six of the 30 wells sampled were field tested for nitrate concentration. Water from 21 of the 26 wells tested had nitrate concentrations of less than 1 mg/L (as N); the remaining samples had concentrations ranging from 4 to 10 mg/L (as N).

**Table 25.** Selected physical and water-quality data from dug wells, February 3, 1984, Oneop Island, Lukunoch Atoll, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Kobayashi	28.5	1,150	--	--	<1	
2	Kioichy	27	750	--	--	<1	
3	Yasuo	27.5	1,200	--	--	10	
4	Iris	29	1,100	--	--	<1	
5	Iowan	28.5	1,150	--	--	<1	
6	Lepukos	31	860	--	--	--	
7	Henry	30	660	--	--	<1	
8	Masaichi	28	600	--	--	5	
9	Kalwin	28	1,150	--	--	<1	
10	Fuktaro	29.5	1,150	--	--	10	
11	Hiram	27.5	1,500	--	--	4	
12	John	28	850	--	--	<1	
13	Melsior	27	420	--	--	<1	
14	Saburo	28.5	850	--	--	<1	
15	Abner	29.5	670	6.9	23	<1	Major ion and trace element sample
16	Mizuo	30	330	--	--	<1	
17	Kenio	--	--	--	--	--	
18	Kition	28	825	--	--	<1	
19	PM	27	860	--	--	<1	
20	Werner	29	555	--	--	<1	
21	Itsuo	29	900	--	--	8	
22	Mission	29.5	530	--	--	<1	
23	Tasy	29	750	--	--	<1	
24	Nowel	28	1,000	--	--	<1	
25	Peterson	28	480	--	--	<1	
26	Kimiji	32	750	--	--	<1	
27	Lusper	27.5	1,150	--	--	<1	
28	Gladwyn	29	800	--	--	<1	
29	Chiro	29	750	--	--	--	
30	Village	--	--	--	--	--	Installed 1 1/4" well point with hand pump



**Figure 33.** Well locations, specific conductance, and nitrate concentrations for Oneop Island, Lukunoch Atoll, Mortlock Island Group, Chuuk State, 1985.

## Ta Island

The population of Ta Island at Satowan Atoll is about 294 (Truk State Office of Planning and Statistics, 1981). Well locations, specific conductance, and nitrate concentrations for Ta Island are shown in figure 34. Selected physical and water-quality data for the 17 dug wells, 1 driven well, and 1 taro patch site sampled are

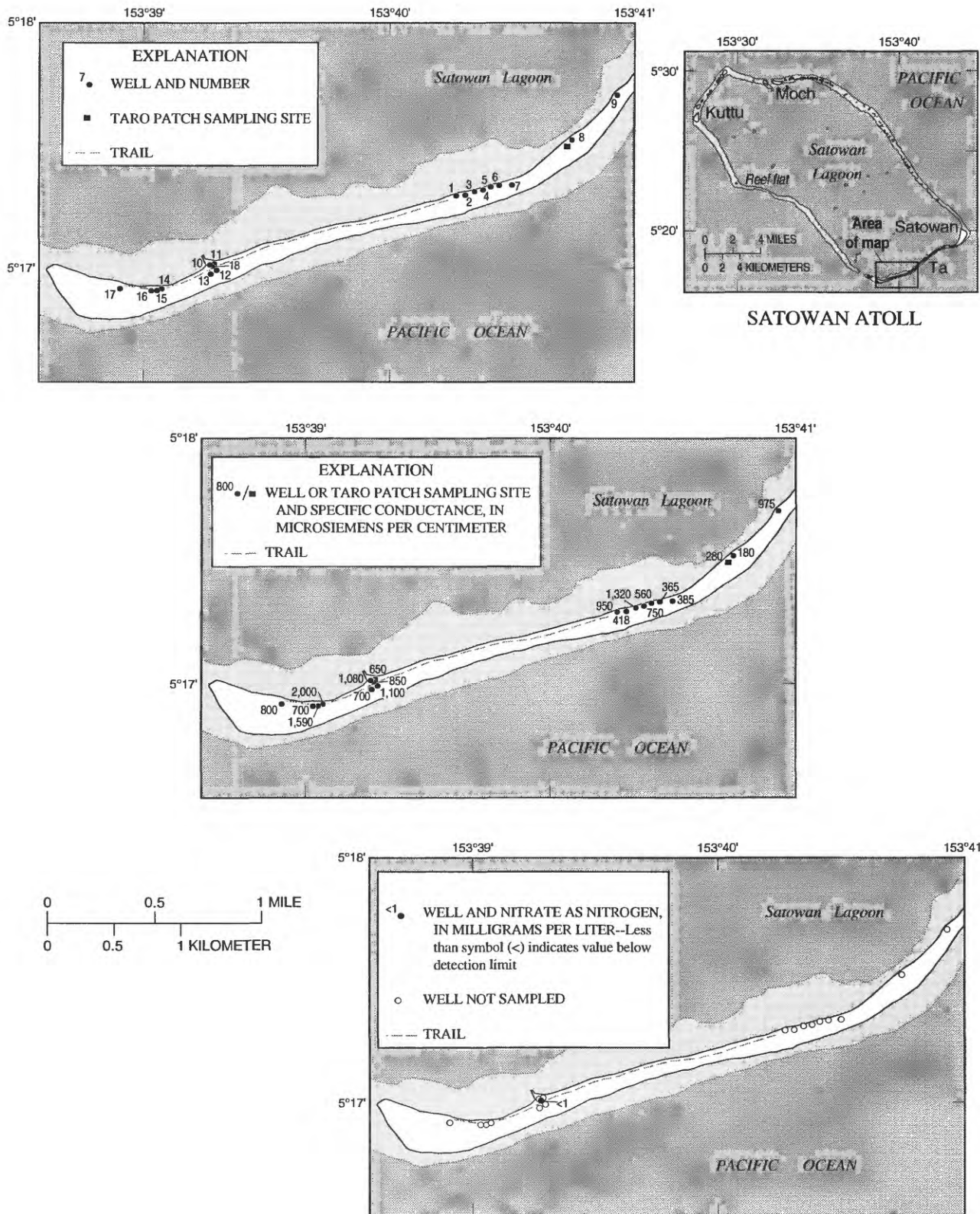
given in table 26. The mean specific conductance for water from 18 wells was 850  $\mu\text{S}/\text{cm}$  and ranged from 180 to 2,000  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from two wells (wells 14 and 15) exceeded the WHO (1984) guideline for chloride. One of the 18 wells sampled was field tested for nitrate concentration, which were less than 1 mg/L (as N).

**Table 26.** Selected physical and water-quality data from dug and driven wells, and taro patch site, October 26–27, 1985, Ta Island, Satowan Atoll, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Siales	28	950	--	--	--	
2	Calep	26.5	418	--	--	--	
3	Eimil	28	1,320	--	--	--	
4	Eifram	29	750	--	--	--	
5	Elmut	27.5	560	--	41	--	
6	Abisay	27	365	--	--	--	
7	Kulio	27	385	--	--	--	
8	Sakios	27	180	--	--	--	
9	Akisima	29	975	--	--	--	
10	Herwin	27	1,080	--	--	--	
11	Inos	27	650	--	--	--	
12	Lepem	27	1,100	--	--	--	
13	Keter	27.5	700	--	--	--	
14	Malon	27	2,000	--	--	--	
15	Eli	27	1,590	--	--	--	
16	Suap	27	700	--	--	--	
17	Achu	27	800	--	--	--	
18	Village	27.5	860	7.1	100	<1	Installed 1 1/4" well point with hand pump
Taro patch		--	280	--	--	--	





**Figure 34.** Well locations, specific conductance, and nitrate concentrations for Ta Island, Satowan Atoll, Mortlock Island Group, Chuuk State, 1984.



## Kuttu Island

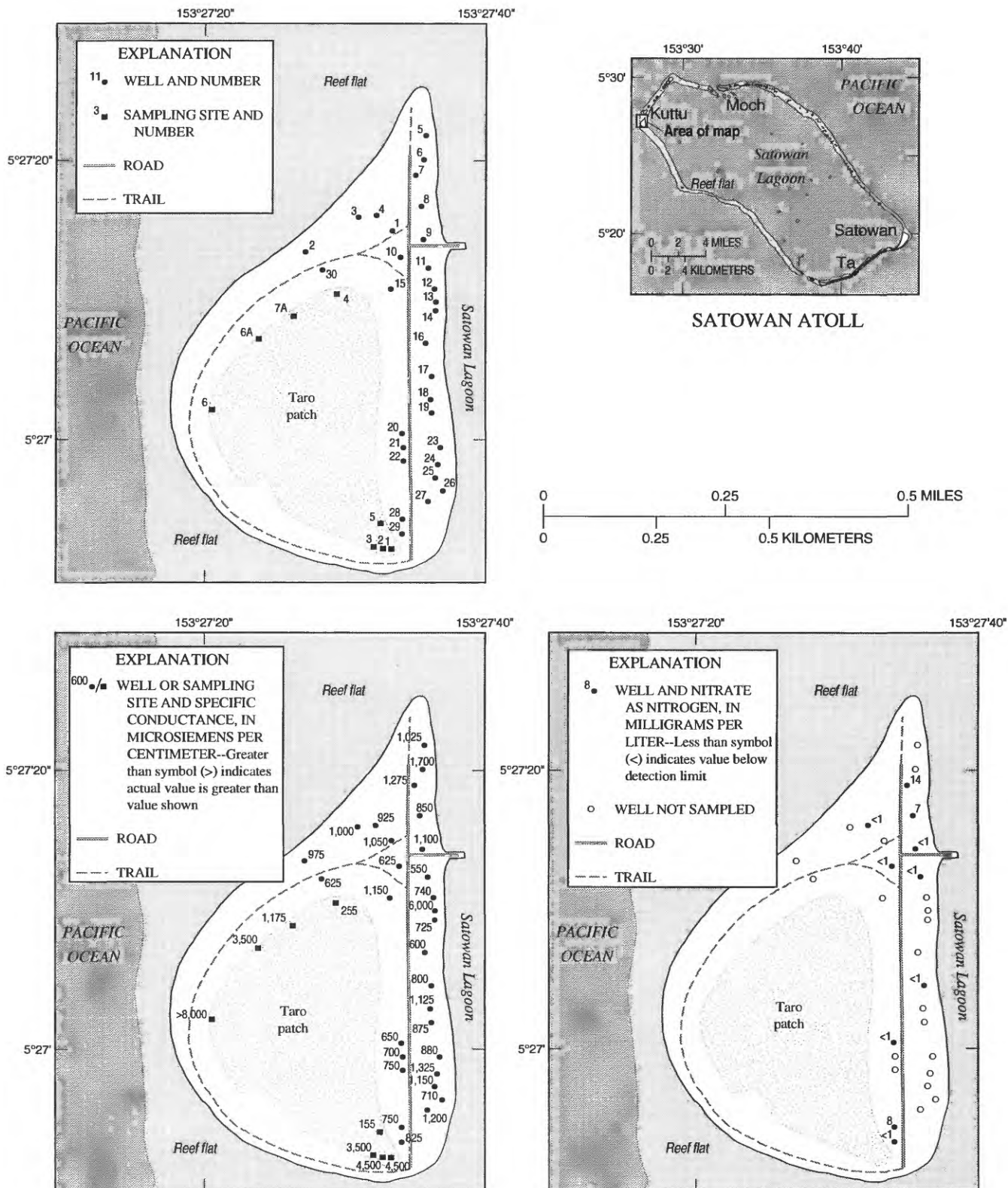
The population of Kuttu Island at Satowan Atoll is about 484 (Truk State Office of Planning and Statistics, 1981). Well locations, sampling sites, specific conductance, and nitrate concentrations for Kuttu Island are shown in figure 35. Selected physical and water-quality data for the 30 dug wells and 8 taro patch sites sampled are given in table 27. The mean specific conductance for water from 30 wells was 1,090  $\mu\text{S}/\text{cm}$  and ranged

from 550 to 6,000  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from 2 of the 30 wells sampled (wells 6 and 13) exceeded the WHO (1984) guideline for chloride. Ten of the 30 wells sampled were field tested for nitrate concentration. Water from 7 of the 10 wells tested had nitrate concentrations of less than 1 mg/L (as N); the remaining samples had concentrations ranging from 7 to 14 mg/L (as N). One of these samples (well 7) exceeded the WHO (1984) guideline for nitrate.

**Table 27.** Selected physical and water-quality data from dug wells and taro patch sites, February 17, 1984, Kuttu Island, Satowan Atoll, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than; >, greater than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Luela	27	1,050	6.8	--	--	
2	Diofil	26.5	975	6.9	--	--	
3	Kapino	26.5	1,000	7.0	--	--	
4	Kos	26.5	925	7.0	--	<1	
5	Masuo	26	1,020	7.3	--	--	
6	Elias	26.5	1,700	7.0	--	--	
7	Daniel	27.5	1,280	7.0	--	14	
8	Roman	27	850	7.2	--	7	
9	Ernest	27	1,100	7.0	--	<1	
10	Hirr	26.5	625	7.1	--	<1	
11	Rufino	26.5	550	7.4	--	<1	
12	Akostin	26.5	740	7.3	--	--	
13	Istino	26	6,000	7.3	1,600	--	
14	Eriper	26.5	725	7.3	--	--	
15	Tasio	27	1,150	7.1	23	--	
16	Atalifus	26.5	600	7.3	--	--	
17	Akira	26	800	7.2	--	<1	
18	Sami	27	1,120	6.9	--	--	
19	Daifus	26.5	875	7.2	--	--	
20	Damel	27	650	7.4	--	<1	
21	Tarech	26.5	700	7.1	8	--	
22	Epel	26.5	750	7.1	--	--	
23	Berman	26.5	880	7.0	--	--	
24	Dofer	26.5	1,320	7.0	--	--	
25	Sam	26.5	1,150	6.9	--	--	
26	Achon	26	710	7.4	15	--	
27	Asauo	26.5	1,200	6.9	--	--	
28	Kutper	27	750	7.4	45	8	Major ion and trace element sample
29	Santer	26.5	825	7.1	--	<1	
30	Michael	26	625	7.2	--	--	
Taro patch 1		27	4,500	--	--	--	
Taro patch 2		27	4,500	--	--	--	
Taro patch 3		28	3,500	--	--	--	
Taro patch 4		28	255	7.7	--	--	
Taro patch 5		27.5	155	7.2	--	--	
Taro patch 6		28.5	>8000	--	--	--	
Taro patch 6A		28	3,500	--	--	--	
Taro patch 7A		28.5	1,175	--	--	--	



**Figure 35.** Well locations, specific conductance, and nitrate concentrations for Kuttu Island, Satowan Atoll, Mortlock Island Group, Chuuk State, 1984.

## Moch Island

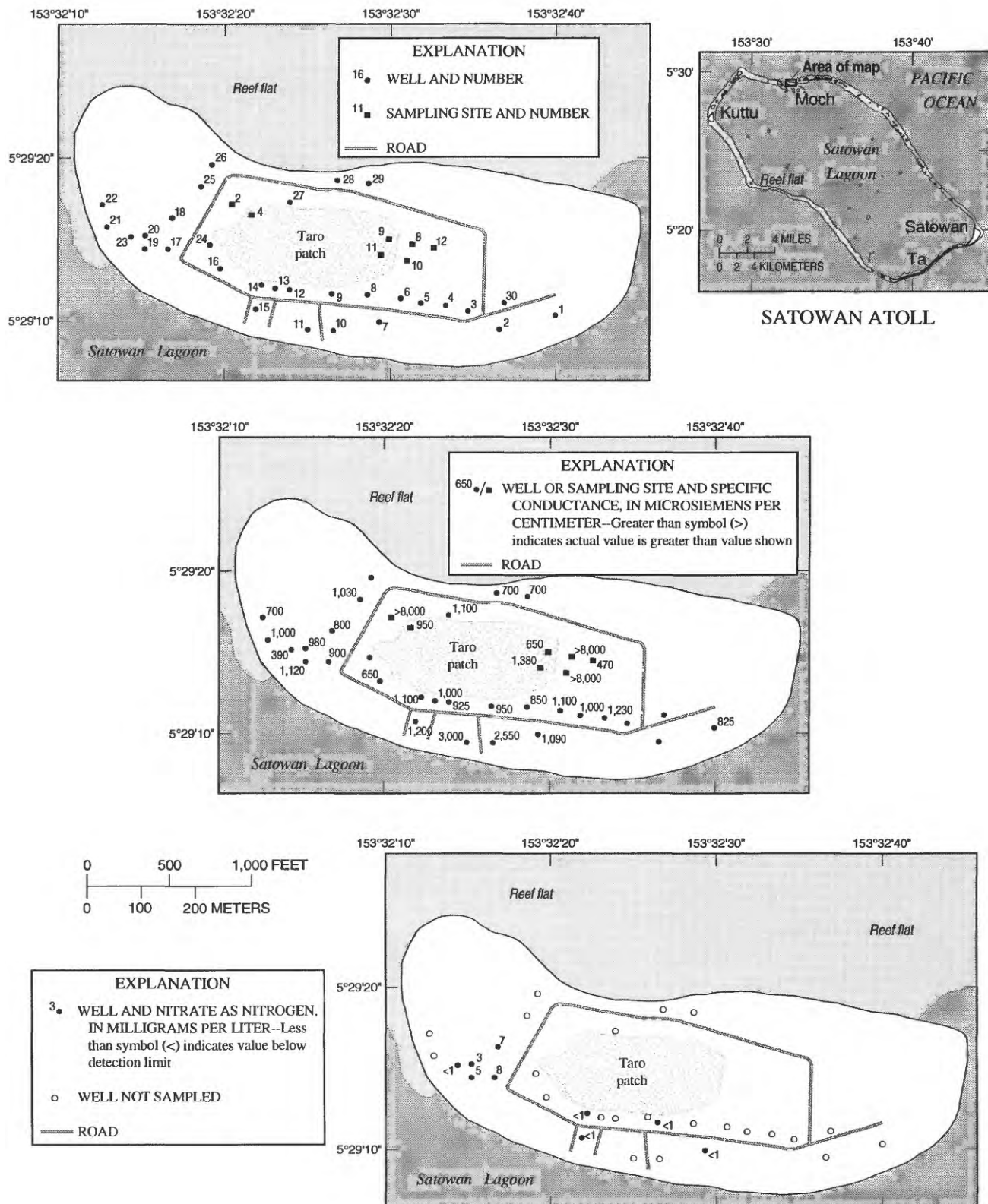
The population of Moch Island at Satowan Atoll is about 622 (Truk State Office of Planning and Statistics, 1981). Well locations, sampling sites, specific conductance, and nitrate concentrations for Moch Island are shown in figure 36. Selected physical and water-quality data for the 30 dug wells and 8 taro patch sites sampled are given in table 28. The mean specific conductance for water from 30 wells was 1,080  $\mu\text{S}/\text{cm}$  and ranged

from 390 to 3,000  $\mu\text{S}/\text{cm}$ . On the basis of the estimated chloride concentrations from specific conductance data, water from 2 of the 30 wells sampled (wells 10 and 11) exceeded the WHO (1984) guideline for chloride. Nine of the 30 wells sampled were field tested for nitrate concentration. Water from 5 of the 30 wells tested had nitrate concentrations of less than 1 mg/L (as N); the remaining samples had concentrations ranging from 3 to 8 mg/L (as N).

**Table 28.** Selected physical and water-quality data from dug wells and taro patch sites, February 18, 1984, Moch Island, Satowan Atoll, Mortlock Island Group

[°C, degrees Celsius;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter at 25 °C; Cl, chloride;  $\text{NO}_3$ , nitrate; mg/L, milligrams per liter; --, not measured; <, less than; >, greater than]

Well no.	Owner	Temperature (°C)	Specific conductance ( $\mu\text{S}/\text{cm}$ )	pH	Cl (mg/L)	$\text{NO}_3$ , as N (mg/L)	Remarks
1	Miako	27	825	6.8	--	--	
2	Herbert	--	--	--	--	--	
3	Misako	--	--	--	--	--	
4	Riony	26.5	1,230	7.3	--	--	
5	Luis	27	1,000	7.2	--	--	
6	Aste	27	1,100	6.8	--	--	
7	Emos	27	1,090	7.4	--	<1	
8	Angket	27	850	6.9	--	--	
9	Sapon	27	950	7.0	--	<1	
10	Achuro	27	2,550	7.2	--	--	
11	Julian	27.5	3,000	7.0	--	--	
12	Mike	27	925	7.0	--	--	
13	Taro	27	1,000	7.1	--	--	
14	Lusio	26	1,100	7.0	--	<1	
15	Robert	28	1,200	7.1	--	<1	
16	Elias	27	650	7.2	30	--	
17	Paulino	27	900	7.3	55	8	
18	Michiuo	27	800	7.3	43	7	Major ion and trace element sample
19	Felix	27	1,120	7.0	--	5	
20	Mauro	27	980	7.2	--	3	
21	Achuro	27	1,000	7.3	--	--	
22	Epari	27	700	7.0	--	--	
23	Kenshy	26	390	7.5	40	<1	
24	Faustino	--	--	--	--	--	
25	Kaime	28	1,030	7.0	--	--	
26	Paulis	--	--	--	--	--	
27	Tanis	27	1,100	6.9	--	--	
28	Max	27	700	7.4	--	--	
29	Antolin	27.5	700	7.1	--	--	
30	Herbert	--	--	7.2	--	--	
Taro patch 2		30	>8000	--	--	--	
Taro patch 4		28.5	950	--	--	--	
Taro patch 8		30	>8000	--	--	--	
Between taro patches 8 and 10		28.5	>8000	--	--	--	
Taro patch 9		28	650	--	--	--	
Taro patch 10		29.5	>8000	--	--	--	
Across wall in patch 10		28	1,380	--	--	--	
Isaias taro patch 12		28	470	--	--	--	



**Figure 36.** Well locations, specific conductance, and nitrate concentrations for Moch Island, Satowan Atoll, Mortlock Island Group, Chuuk State, 1984.



## SUMMARY

A ground-water-quality reconnaissance of 24 inhabited outer islands in Chuuk State was made between January 1984 and October 1985. A total of 648 wells were located, described, and sampled for temperature and specific conductance. The nitrate concentration was determined for 308 water samples. To develop a relation between specific conductance and chloride concentration, the chloride concentration was determined for 63 water samples. In addition, 21 water samples were analyzed for major and trace constituent ion concentrations.

Water supplies in the inhabited outer islands of Chuuk State are entirely dependent on rainfall, directly from catchment and indirectly as recharge to ground water. During normal climatic conditions, rainfall-catchment systems are capable of supplying potable water. However, during extended dry periods or droughts, ground water becomes the primary supply for potable water. Under favorable conditions, the freshwater lens acts as a storage reservoir for infiltration from rainfall.

The size and shape of a freshwater lens is controlled by: (1) ground-water recharge and discharge, (2) the hydraulic characteristics (chiefly permeability) of sediments, and (3) island morphology or the size, shape, and presence of a lagoon. Large, circular islands tend to have larger freshwater lenses than small, elongated islands because of their larger storage capacity and less mixing with seawater. The presence of an adjacent lagoon also increases storage in the freshwater lens by acting as a buffer to wave action and allowing accumulation of fine-grained sediments. The thickest part of the lens is associated with fine-grained sediments which, as a result of low permeability, retard mixing of freshwater with seawater.

Chloride and nitrate are the primary constituents that determine the potability of ground water in the inhabited outer islands of Chuuk State. Factors such as shape and size of the island and land-use affect the concentration of these constituents. The source of chloride in ground water is seawater that has been introduced through intrusion, wave washover, and seaspray. Human activities can contaminate ground water with nitrate and pathogenic bacteria. These activities include the disposal of human and animal waste, the application of fertilizers for agriculture, bathing, and the washing of

cookware and clothes. Safe-drinking-water guidelines in ground water may be exceeded as a result of these activities.

A statistical summary of specific conductance data collected, including the number of wells sampled, and number of samples exceeding the WHO (1984) drinking-water guideline for chloride is presented in table 29. Although chloride concentration was not determined for all of the wells sampled, it may be estimated from the specific conductance data. For example, values of specific conductance less than 1,500 uS/cm generally are within the WHO (1984) guideline for chloride (250 mg/L). In the Western Island Group, the guideline for chloride was exceeded for 60 percent of the wells sampled on Tamatam Island, 14 percent of the wells sampled on Pollap Island, and none of the wells sampled on Polowat and Houk Islands. In the Namonweito Island Group, the guideline for chloride was exceeded for 100 percent of the wells sampled on Onou and Unanu Islands, and between 14 and 29 percent of the wells sampled on Onoun, Makur, and Piherarh. In the Hall Island Group, the guideline for chloride was exceeded for 80 percent of the wells sampled on Fananu Island, 40 percent of the wells sampled on Ruo Island, and between 13 and 17 percent of the wells sampled on Nomwin and Murilo Islands. In the Mortlock Island Group, the guideline for chloride was exceeded for between 11 and 33 percent of the wells sampled on Nema, Losap, and Ta Islands, between 2 and 7 percent of the wells sampled on Piis-Emwar, Lukunoch, Satowan, Kuttu, and Moch Islands, and none of the wells sampled on Namoluk and Ettal Islands.

A statistical summary of nitrate-concentration data collected, including the number of wells sampled, and number of samples exceeding the WHO (1984) drinking-water guideline for nitrate is presented in table 30. The WHO (1984) drinking-water guideline for nitrate is 10 mg/L (as N). Six of the 308 water samples analyzed for nitrate exceeded the WHO (1984) guideline for nitrate; which represents 5 percent of the wells sampled on Onoun and Piherarh in the Namonweito Island Group, 12 percent of the wells sampled on Nomwin in the Hall Island Group, and 10 percent of the wells sampled on Kuttu in the Mortlock Island Group.



**Table 29.** Summary of specific conductance data for islands in the Western, Namonweito, Hall, and Mortlock Island Groups, Chuuk State  
 [WHO, World Health Organization;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter]

Island	Number of wells sampled for specific conductance	Specific conductance (μS/cm)			Number of samples exceeding the WHO (1984) guideline for chloride
		Maximum	Minimum	Mean	
Western Island Group					
Pollap	21	10,000	370	1,450	3
Tamatam	5	2,400	700	1,510	3
Polowat	32	1,500	270	790	0
Houk	7	1,100	390	700	0
Namonweito Island Group					
Onoun	41	1,750	335	1,070	6
Makur	6	3,000	710	1,220	1
Onou	2	7,500	6,000	6,750	2
Unanu	8	6,000	2,000	3,340	8
Piherarh	17	6,000	775	1,790	5
Hall Island Group					
Nomwin	24	2,700	580	1,210	4
Fananu	10	4,000	600	2,060	8
Murilo	15	1,950	650	1,120	2
Ruo	10	6,000	250	1,860	4
Mortlock Island Group					
Nema	12	8,000	750	2,650	4
Losap	24	3,700	620	1,260	6
Piis-Emwar	19	1,700	560	940	1
Namoluk	29	1,300	300	660	0
Ettal	38	1,330	360	750	0
Lukunoch	56	2,600	400	830	1
Satowan	64	1,700	210	710	1
Oneop	30	1,500	330	850	0
Ta	18	2,000	180	850	2
Kuttu	30	6,000	550	1,090	2
Moch	30	3,000	390	1,080	2

**Table 30.** Summary of nitrate-concentration data for islands in the Western, Namonweito, Hall, and Mortlock Island Groups, Chuuk State

[WHO, World Health Organization; mg/L, milligrams per liter; <, less than]

Island	Number of wells sampled for nitrate concentration	Nitrate concentration, as N (mg/L)		Number of samples below detection limit	Number of samples exceeding the WHO (1984) guideline for nitrate
		Maximum	Minimum		
Western Island Group					
Pollap	7	5	<1	6	0
Tamatam	4	7	<1	2	0
Polowat	5	<1	<1	5	0
Houk	5	10	<1	2	0
Namonweito Island Group					
Onoun	41	15	<1	19	2
Makur	6	6	2	0	0
Onou	2	2	1	0	0
Unanu	6	5	<1	2	0
Piherarh	18	11	1	0	1
Hall Island Group					
Nomwin	17	18	<1	8	2
Fananu	9	4	<1	4	0
Murilo	7	10	<1	3	0
Ruo	4	7	<1	2	0
Mortlock Island Group					
Nema	6	3	<1	3	0
Losap	22	6	<1	15	0
Piis-Ernwar	15	4	<1	12	0
Namoluk	11	9	<1	8	0
Ettal	6	4	<1	4	0
Lukunoch	33	4	<1	32	0
Satowan	38	5.5	<1	32	0
Oneop	26	10	<1	21	0
Ta	1	<1	<1	1	0
Kuttu	10	14	<1	7	1
Moch	9	8	<1	5	0

## REFERENCES CITED

- Anthony, S.S., Peterson, F.L., Mackenzie, F.T., and Hamlin, S.N., 1989, Geohydrology of the Laura fresh-water lens, Majuro Atoll: A hydrogeochemical approach: Geological Society of America Bulletin, v. 101, p. 1066–1075.
- Ayers, J.F. and Clayshulte, R.N., 1985, Reconnaissance level investigation of salt-water intrusion on Kuttu Island, Satawan Atoll, Truk State: University of Guam, Water and Energy Research Institute Report No. 48, 70 p.
- Ayers, J.F. and Vacher, H.L., 1986, Hydrogeology of an atoll island: A conceptual model from detailed study of a Micronesian example: Ground Water, v. 24, p. 185–198.
- Hamlin, S.N. and Anthony, S.S., 1987, Ground-water resources of the Laura Area, Majuro Atoll, Marshall Islands: U.S. Geological Survey Water Resources Investigations Report 87-4047, 69 p.
- Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 2254, 263 p.
- National Oceanic and Atmospheric Administration, 1987, Climatological data, Hawaii and Pacific: Department of Commerce, v. 83, nos. 1–12, paginated separately.
- National Oceanic and Atmospheric Administration, 1988, Climatological data, Hawaii and Pacific: Department of Commerce, v. 84, nos. 1–12, paginated separately.
- Schlanger, S.O., 1963, Subsurface geology of Eniwetok Atoll: U.S. Geological Survey Professional Paper 260-B., p. 991–1066.
- Stark, J.T., Paseur, J.E., May, H.G., and Patterson, E.D., 1958, Military geology of Truk Islands, Caroline Islands: Headquarters U.S. Army Pacific, Office of the Engineer, 207 p.
- Taylor, R.C., 1973, An atlas of Pacific Islands rainfall: Hawaii Institute of Geophysics, University of Hawaii, HIG-73-9, Data Report No. 25, app. A–E.
- Truk State Office of Planning and Statistics, 1981, Statistical Yearbook, Truk State, FSM: Unpublished report, 72 p.
- van der Brug, Otto, 1986, The 1983 drought in the Western Pacific: U.S. Geological Survey Open-File Report 85-418, 89 p.
- World Health Organization, 1984, Guidelines for drinking-water quality, volume 1 of 3: Geneva, Switzerland, 130 p.